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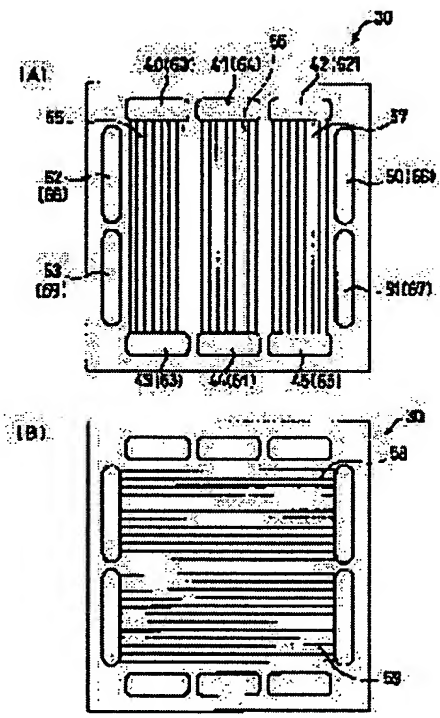
(54) GAS SEPARATOR FOR FUEL CELL AND FUEL CELL USING THE GAS SEPARATOR FOR THE FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To enhance the utilization factor of gas supplied to a fuel cell.
SOLUTION: A separator 30 has holes 40-45 and ribs 55-57 for connecting respective facing holes. Oxidizing gas, supplied from an oxidizing gas supply device to a fuel cell assembled by using the separator 30, is passed through a oxidizing gas supply manifold formed with the hole 40, distributed into an oxidizing gas flow path within a unit cell formed with the ribs 55, and the distributed oxidizing gas is joined in an oxidizing gas exhaust manifold formed with the hole 43. The oxidizing gas is guided by return plates disposed at the end of the fuel cell and introduced into an oxidizing gas supply manifold formed with the hole 44, and distributed into a gas flow path within the unit cell. The oxidizing gas is sequentially passed through the oxidizing gas flow paths within the unit cell formed with ribs 55-57 respectively.



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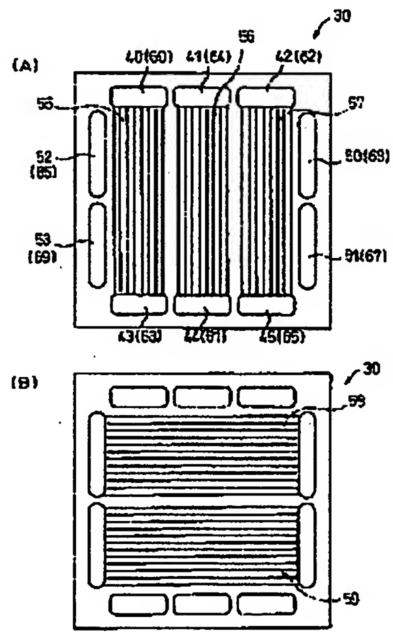
(54)【発明の名称】　燃料電池用ガスセパレータおよび該燃料電池用ガスセパレータを用いた燃料電池

(57)【要約】
【課題】　燃料電池に供給するガスの利用率を向上させる。
【解決手段】　セパレータ３０は、孔部４０～４５と、対向する孔部同士をそれぞれ連絡するリブ部５５～５７を備えている。このセパレータ３０を用いて構成した燃料電池に対して酸化ガス供給装置から供給された酸化ガスは、孔部４０によって形成される酸化ガス供給マニホールドを通過しつつ、リブ部５５によって形成される単セル内酸化ガス流路に分配され、孔部４３によって形成される酸化ガス排出マニホールドで合流する。この酸化ガスは、燃料電池端部に配設されたリターンプレートに導かれて、孔部４４によって形成される酸化ガス供給マニホールドに導入され、さらに、リブ部５６によって形成される単セル内ガス流路に分配される。このように酸化ガスは、リブ部５５～５７のそれぞれによって形成される単セル内酸化ガス流路を順次通過する。



【特許請求の範囲】

【請求項１】　電解質層および電極を形成する部材と共に積層することによって燃料電池を構成可能となり、該燃料電池内部でガス流路を形成する燃料電池用ガスセパレータであって、

該燃料電池用ガスセパレータをその厚み方向に貫通する２つの孔構造と、該２つの孔構造を前記燃料電池用ガスセパレータの一方の面の上で連通させる凹部とからなる単セル内流路形成部を、それぞれ独立して互いに連通することなく、前記燃料電池用ガスセパレータの前記面側において複数形成し、

前記燃料電池用ガスセパレータを積層して燃料電池を構成する際には、前記単セル内流路形成部によって前記ガス流路を形成することを特徴とする燃料電池用ガスセパレータ。

【請求項２】　前記複数の単セル内流路形成部を、その両面に有する請求項１記載の燃料電池用ガスセパレータ。

【請求項３】　請求項１記載の燃料電池用ガスセパレータであって、

該燃料電池用ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が同一の方向を向き、かつ、互いに隣接するように配置されており、

複数の前記単セル内流路形成部がそれぞれ２つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの辺縁部に沿って、互いに隣接するように配置されていることを特徴とする燃料電池用ガスセパレータ。

【請求項４】　請求項１記載の燃料電池用ガスセパレータであって、

前記複数の単セル内流路形成部を前記燃料電池用ガスセパレータの両面に備え、

前記燃料電池用ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が第１の方向を向き、かつ、互いに隣接するように配置されており、

前記燃料電池用ガスセパレータの他方の面上に形成される複数の前記凹部は、前記他方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が前記第１の方向とは逆向きの第２の方向を向き、かつ、互いに隣接するように配置されており、

前記燃料電池用ガスセパレータの一方の面上に形成される複数の前記単セル内流路形成部がそれぞれ２つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの第１の辺縁部に沿って、互いに隣接するように配置されており、

前記燃料電池用ガスセパレータの他方の面上に形成される複数の前記単セル内流路形成部がそれぞれ２つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの前記第１の辺縁部と対向する第２の辺縁部に沿って、互いに隣接するように配置されていることを特徴とする燃料電池用ガスセパレータ。

【請求項５】　電解質層と電極およびガスセパレータを含む部材からなる単セルを複数積層してなるスタック構造を有し、電極活物質を含有するガスの供給を受けて、電気化学反応により起電力を得る燃料電池であって、

前記スタック構造は、内部を前記ガスが通過する流路として、複数の分割流路形成部を備え、

前記複数の分割流路形成部のそれぞれは、前記スタック構造の積層方向に形成される流路であって、内部を通過する前記ガスを各単セルに分配するガス供給マニホールドと、前記スタック構造の積層方向に形成される流路であって、各単セルから排出される前記ガスが集合するガス排出マニホールドと、前記スタック構造を構成する各単セル内に形成され、前記ガス供給マニホールドと前記ガス排出マニホールドとを連通させて、前記各単セルを構成する前記電解質層および前記電極の一部の領域に対して前記ガスを給排する単セル内ガス流路とからなり、

前記各単セルが備えるそれぞれの前記ガスセパレータにおける少なくとも一方の面上では、前記分割流路形成部が備える前記単セル内ガス流路を形成する凹部が、前記複数の分割流路形成部のそれぞれに対応して、互いに連通することなく複数設けられており、

前記スタック構造の端部において、前記複数の分割流路形成部のうちの一つが備える前記ガス排出マニホールドの端部と、前記複数の分割流路形成部のうちの他の一つが備える前記ガス供給マニホールドの端部とを接続する流路接続部を備え、

前記燃料電池に供給された前記ガスは、前記複数の分割流路形成部を、前記流路接続部を介しながら順次通過することを特徴とする燃料電池。

【請求項６】　請求項５記載の燃料電池であって、

前記電極活物質を含有するガスは、酸素を含有する酸化ガスであり、

それぞれの前記単セルにおいて、前記酸化ガスが流入する前記単セル内ガス流路は、内部を通過する前記酸化ガスの流れの方向が、重力に従う場合と同様に上方から下方へ向かう方向となるように形成された燃料電池。

【請求項７】　請求項５記載の燃料電池であって、

前記分割流路形成部が備える前記ガス供給マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路に対して、前記ガスを同時に供給し、

前記分割流路形成部が備える前記ガス排出マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路から同時に排出される前記ガスが集合することを特徴とする燃料電池。

【請求項８】　請求項５記載の燃料電池であって、

前記スタック構造の積層方向に形成され、前記ガス供給マニホールドあるいは前記ガス排出マニホールドとして

働く複数の管状構造を備え、
前記管状構造の少なくとも一つは、内部の所定の位置に、内部を通過するガスの流れを遮断する遮断部を有し、
前記遮断部よりも前記ガスの流れの上流側に配設された前記単セルでは、前記遮断部を有する前記管状構造を前記ガス供給マニホールドとして働かせ、前記上流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスが同時に供給され、前記遮断部よりも前記ガスの流れの下流側に配設された前記単セルでは、前記遮断部よりも上流側で前記ガス排出マニホールドとして働いた前記管状構造を前記ガス供給マニホールドとして働かせ、前記下流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスを同時に供給することを特徴とする燃料電池。
【請求項9】 請求項5記載の燃料電池であって、
該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、
前記燃料電池に供給される前記ガスは、予め分割された後に複数の前記スタック構造のそれぞれに対して供給されることを特徴とする燃料電池。
【請求項10】 請求項5記載の燃料電池であって、
該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、
複数の前記スタック構造の内の所定の一つに供給された前記ガスは、該所定のスタック構造が備える複数の前記分割流路形成部を順次通過する途中で、前記所定のスタック構造とは異なる前記スタック構造が備える前記分割流路形成部を経由することを特徴とする燃料電池。
【請求項11】 請求項5記載の燃料電池であって、
前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が同一の方向を向き、かつ、互いに隣接するように配置されており、
それぞれの前記凹部が形成する前記単セル内ガス流路は、U字形をなす前記凹部の両端部において、前記ガス供給マニホールドおよび前記ガス排出マニホールドと接続し、
前記複数の分割流路形成部のそれぞれが備える前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の側面の一つに沿って互いに隣接して配設されることを特徴とする燃料電池。
【請求項12】 請求項5記載の燃料電池であって、
前記ガスセパレータは、前記複数の凹部を、その両面にそれぞれ有し、
前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が第1の方向を向き、かつ、互いに隣接するように配置されており、
前記ガスセパレータの他方の面上に形成される複数の前記凹部は、前記他方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が前記第1の方向とは逆向きの第2の方向を向き、かつ、互いに隣接するように配置されており、
前記ガスセパレータの一方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第1の側面に沿って、互いに隣接するように配設され、
前記ガスセパレータの他方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第1の側面と対向する第2の側面に沿って、互いに隣接するように配設されていることを特徴とする燃料電池。
【請求項13】 請求項11記載の燃料電池であって、
燃料電池内部との間で熱交換することによって、前記電気化学反応に伴って生じる熱を取り除いて、燃料電池内部の温度が非所望の温度に上昇してしまうのを防ぐ冷却液を、その内部に通過させる流路であって、燃料電池内部の所定の複数の位置に設けられた冷却液路と、
前記スタック構造の積層方向に形成され、前記冷却液を前記冷却液路に分配する、あるいは、前記各冷却液路を通過した前記冷却液が集合する冷却液マニホールドとを備え、
前記冷却液マニホールドは、前記スタック構造を形成する側面の一つに沿って互いに隣接して設けられた前記ガス供給マニホールドおよび前記ガス排出マニホールドの近傍に設けられ、前記ガス供給マニホールドおよび前記ガス排出マニホールドが配設された位置よりも、前記単セル内ガス流路が形成される場所から離れた位置に設けられたことを特徴とする燃料電池。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、燃料電池用ガスセパレータ並びに該燃料電池用ガスセパレータを用いた燃料電池に関し、詳しくは、単セルを複数積層して構成する燃料電池において、隣接する単セル間に設けられ、隣接する部材との間で燃料ガス流路および酸化ガス流路を形成すると共に、燃料ガスと酸化ガスとを隔てる燃料電池用セパレータ、並びに該セパレータを用いた燃料電池に関する。
【0002】
【従来の技術】燃料電池用ガスセパレータは、複数の単セルが積層された燃料電池スタックを構成する部材であって、充分なガス不透過性を備えることによって、隣り合う単セルのそれぞれに供給される燃料ガスおよび酸化ガスが混じり合うのを防いでいる。このような燃料電池用セパレータは、通常は表面にリブ状などの凹凸構造を有しており、燃料ガスおよび酸化ガスの流路を形成する

働きも有している（このような構成のガスセパレータは、リブ付きインターコネクタとも呼ばれる）。すなわち、燃料電池用セパレータは、燃料電池スタックに組み込まれたときには、隣接する部材（ガス拡散層）と上記凹凸構造との間で、燃料ガスまたは酸化ガスの流路（単セル内流路）を形成する。

【０００３】また、燃料電池用ガスセパレータは、上記したガス流路を形成する凹凸構造の他に、所定の孔構造を有している。この孔構造は、ガスセパレータを備える単セルを積層して燃料電池スタックを構成したときには、隣り合うガスセパレータに備えられた対応する孔構造同士が重なって、燃料電池スタック内をその積層方向に貫くガスマニホールドを構成する。このようなガスマニホールドは、燃料電池の外部から供給される燃料ガスまたは酸化ガスを内部に通過させつつ各単セルに分配したり、各単セルで電気化学反応に供された後の燃料排ガスあるいは酸化排ガスが導入されてこれらを燃料電池外部に導いたりする。したがって、これらのガスマニホールドは、積層された各単セルに形成される上記単セル内流路と連通しており、ガスマニホールドと単セル内流路との間でガスを流出入可能となっている。

【０００４】図３２は、従来知られるガスセパレータの一例として、セパレータ１３０の構成を平面的に表わす説明図である。セパレータ１３０は、その周辺近くに、４つの孔構造として、空気孔１４０，１４３と、燃料孔１５０，１５２とを備えている。これらの空気孔および燃料孔は、セパレータ１３０を含む部材を積層して燃料電池を構成する際には、燃料電池の内部で、それぞれ、酸化ガス供給マニホールド、酸化ガス排出マニホールド、燃料ガス供給マニホールド、燃料ガス排出マニホールドを形成する。

【０００５】また、セパレータ１３０の一方の面には、空気孔１４０と空気孔１４３とを連絡するリブ部１５５が設けられており、セパレータ１３０の他方の面には、燃料孔１５０と燃料孔１５２とを連絡するリブ部（図示せず）が設けられている。ここでは、これらのリブ部は、平行に形成された溝状構造とした。セパレータ１３０を含む部材を積層して燃料電池を構成する際には、これらのリブ部は、セパレータ１３０に隣接する部材との間で、単セル内ガス流路を形成する。すなわち、空気孔１４０と空気孔１４３とを連絡するリブ部１５５は、単セル内酸化ガス流路を形成し、燃料孔１５０と燃料孔１５２とを連絡するリブ部は、単セル内燃料ガス流路を形成する。燃料電池に供給された酸化ガスは、空気孔１４０によって形成される酸化ガス供給マニホールド内を通過し、各単セル内に形成された単セル内酸化ガス流路に分配され、電気化学反応に供された後に酸化ガス排出マニホールドで合流して、燃料電池外部に排出される。同様に、燃料電池に供給された燃料ガスは、燃料孔１５０によって形成される燃料ガス供給マニホールド内を通過し、各単セル内に形成された単セル内燃料ガス流路に分配され、電気化学反応に供された後に燃料ガス排出マニホールドで合流して、燃料電池外部に排出される。

【０００６】このような、燃料ガスおよび酸化ガスを電気化学反応に供して起電力を得る燃料電池では、供給されるガスの利用率を向上させることが望まれている。すなわち、燃料電池には、電極活物質（水素あるいは酸素）を含有するガス（燃料ガスあるいは酸化ガス）が供給されるが、ガス中の電極活物質のすべてが電気化学反応で利用され得るわけではないので、電気化学反応を充分に進行させるために、理論上必要とされる量を超える量の電極活物質を含有するガスを燃料電池に供給している。したがって、ガス中の電極活物質を電気化学反応で利用されやすくしてガスの利用率を向上させて、燃料電池に供給するガス量を抑えることが望まれている。燃料電池に供給するガス量が抑えられれば、燃料ガスにおいては水素の消費量を抑えることができる。また、酸化ガスにおいては、酸化ガス（通常は空気）を加圧するために消費するエネルギ量を抑えることができ、燃料電池を備えるシステム全体のエネルギ効率を向上させることができる。

【０００７】ガス中の電極活物質を電気化学反応で利用されやすくしてガスの利用率を向上させるには、ガスが流路内でよく撹拌され、拡散する状態とすればよい。これによって、電極に備えられた触媒と電極活物質とを接触しやすくすることができる。ガスが流路内でよく撹拌され、拡散する状態とするには、例えば、単セル内流路において、この流路内を通過するガスの流量を増やして流速を速くする方法を選択することができる。流路内を通過するガスの流量を増やす方法として、単セル内流路の流路断面を小さくする方法が考えられるが、このような構成として、ガスセパレータ上に形成されて単セル内流路を形成する上記凹凸構造の形状を、一筆書き構造とする構成が提案されている（例えば、特開平７－２６３００３号公報等）。ここでは、各単セルに供給されるガスは、同一面上に連続して形成された細い流路内に導入される。したがって、外部から燃料電池に供給するガス量は同じであっても、図３２に示した構成のように、各単セル内において同一面上のより広い範囲に同時にガスを通過させる構成とする場合に比べて、流路の任意の場所を通過するガスの流速を速くすることができ、ガスの利用率を向上させることができる。

【０００８】

【発明が解決しようとする課題】しかしながら、ガスセパレータ上に形成された凹凸構造を、上記したような一筆書き構造とする場合には、単セル内流路は同一面上で細かく折り曲げられるため、このような単セル内流路をガスが通過する際に生じる圧損が大きくなってしまう。したがって、流路内を通過するガスの流量を所定量に維持するためには、燃料電池に供給するガスを加圧する程

度を大きくする必要があり、これによってガスを加圧するために消費するエネルギが増大して、燃料電池を備えるシステム全体のエネルギ効率が低下してしまうという不都合を生じる。

【０００９】上記公報とは別に、セパレータ上に形成するガス流路を複数の領域に分割する構成も提案されている（例えば、実開昭５８－１３８２６８号公報等）。このような燃料電池では、ガスセパレータ（バイポーラプレート）上に、複数の領域に分割されたガス流路が形成されている。ガス供給孔から単セル内に供給されたガスは、上記複数の領域を順次通過してガス排出口に到る。このような構成としても、流路内を通過するガスの流速を速くしてガス利用率を向上させることができるが、上記一筆書きの構造と同様にガスの流れが単セル内で連続しており、さらに、ガス集合孔同士を絞りによって接続しているため、上記圧損の問題を充分に解決することができない。また、特開平７－２６３００３号公報に示された構成、および実開昭５８－１３８２６８号公報に示された構成ともに、単セル内でガスの流れが連続しているため、各単セルへのガスの分配が充分均一に行なわれないおそれがある。

【００１０】また、上記したように単セル内流路の流路断面を小さくする場合には、ガスセパレータ上に形成する凹凸構造をより細かく形成する必要があるが、これによって、ガスセパレータを製造する際に従来以上の精度が要求されることになる。しかしながら、ガスセパレータの製造時において、その表面に凹凸構造を形成する際の精度を向上させることは困難を伴い、精度が不十分となった場合には、製造時の歩留まりの低下（不良品の増加）や、凹凸構造を形成する際の精度の低下に起因する電池性能のばらつきなどの不都合が生じるおそれがある。

【００１１】本発明の燃料電池用ガスセパレータおよび該燃料電池用ガスセパレータを用いた燃料電池は、こうした問題を解決し、燃料電池を備えるシステム全体のエネルギ効率を低下させてしまうことなく、燃料電池に供給するガスの利用率を向上させることを目的としてなされ、次の構成を採った。

【００１２】

【課題を解決するための手段およびその作用・効果】本発明の燃料電池用ガスセパレータは、電解質層および電極を形成する部材と共に積層することによって燃料電池を構成可能となり、該燃料電池内部でガス流路を形成する燃料電池用ガスセパレータであって、該燃料電池用ガスセパレータをその厚み方向に貫通する２つの孔構造と、該２つの孔構造を前記燃料電池用ガスセパレータの一方の面の上で連通させる凹部とからなる単セル内流路形成部を、それぞれ独立して互いに連通することなく、前記燃料電池用ガスセパレータの前記面側において複数形成し、前記燃料電池用ガスセパレータを積層して燃料電池を構成する際には、前記単セル内流路形成部によって前記ガス流路を形成することを要旨とする。

【００１３】以上のように構成された本発明の燃料電池用ガスセパレータは、このガスセパレータを積層して燃料電池を構成する際には、個々の単セル内流路形成部を構成する２つの孔構造によって、ガスセパレータの積層方向にガスを通過させるガス流路（ガスマニホールド）を形成する。また、前記ガスセパレータの一方の面の上で前記２つの孔構造を連通させる前記凹部によって、前記電解質層および前記電極に対してガスを供給するガス流路（単セル内ガス流路）を形成する。ここで、前記ガスセパレータの前記面側において、前記２つの孔構造と前記凹部とからなる単セル内ガス流路形成部は、それぞれ独立して互いに連通することなく複数形成されているので、燃料電池に供給されたガスが、前記ガスセパレータ表面に形成されるガス流路に分配されるときには、所定のガスセパレータ表面の全面に対して、単一のガスマニホールドから一度にガスが供給されることがない。燃料電池に供給されたガスが分配されるときには、ガスセパレータの表面を分割して設けられた単セル内流路形成部が形成する個々の単セル内ガス流路ごとに、それぞれ別個のガスマニホールドからガスが供給される。

【００１４】また、本発明の燃料電池は、電解質層と電極およびガスセパレータを含む部材からなる単セルを複数積層してなるスタック構造を有し、電極活物質を含有するガスの供給を受けて、電気化学反応により起電力を得る燃料電池であって、前記スタック構造は、内部を前記ガスが通過する流路として、複数の分割流路形成部を備え、前記複数の分割流路形成部のそれぞれは、前記スタック構造の積層方向に形成され、内部を通過する前記ガスを各単セルに分配するガス供給マニホールドと、前記スタック構造の積層方向に形成され、各単セルから排出される前記ガスが集合するガス排出マニホールドと、前記スタック構造を構成する各単セル内に形成され、前記ガス供給マニホールドと前記ガス排出マニホールドとを連通させて、前記各単セルを構成する前記電解質層および前記電極の一部の領域に対して前記ガスを給排する単セル内ガス流路とからなり、前記各単セルが備えるそれぞれの前記ガスセパレータにおける少なくとも一方の面上では、前記分割流路形成部が備える前記単セル内ガス流路を形成する凹部が、前記複数の分割流路形成部のそれぞれに対応して、互いに連通することなく複数設けられており、前記スタック構造の端部において、前記複数の分割流路形成部のうちの一つが備える前記ガス排出マニホールドの端部と、前記複数の分割流路形成部のうちの他の一つが備える前記ガス供給マニホールドの端部とを接続する流路接続部を備え、前記燃料電池に供給された前記ガスは、前記複数の分割流路形成部を、前記流路接続部を介しながら順次通過することを要旨とする。

【００１５】以上のように構成された本発明の燃料電池

が備えるスタック構造は、複数の分割流路形成部内を備える。個々の分割流路形成部は、それぞれ、2つのガスマニホールドと、この2つのガスマニホールドと連通して各単セルにおいて設けられた単セル内ガス流路とから形成されており、前記分割流路形成部内では、前記ガスは、一方のガスマニホールドの内部を前記スタック構造の積層方向に通過しつつ、該一方のガスマニホールドに連通するそれぞれの前記単セル内ガス流路に分配されて各単セルにおける電気化学反応に供され、前記各単セル内ガス流路から、さらに他方のガスマニホールドに排出されて、該他方のガスマニホールド内を前記スタック構造の積層方向に通過する。複数の分割流路形成部は、それぞれの分割流路形成部が備える前記ガスマニホールド端部において、前記流路接続部によって順次接続され、外部から供給されたガスは、前記分割流路形成部を順次通過する。

【0016】ここで、各単セルが備える前記ガスセパレータにおける少なくとも一方の面上では、前記単セル内ガス流路を形成する凹部が設けられており、この凹部は、前記複数の分割流路形成部のそれぞれに対応して設けられている。これら複数の凹部は、ガスセパレータの一方の面上で互いに連通することなく形成されているため、燃料電池に供給されたガスが単セル内部に形成されたガス流路に分配されるときには、所定のガスセパレータ表面の全面に対して、単一のガスマニホールドから一度にガスが供給されることがない。燃料電池に供給されたガスが分配されるときには、ガスセパレータの表面を分割して設けられた前記凹部が形成する個々の単セル内ガス流路ごとに、それぞれ別個のガスマニホールドからガスが供給される。

【0017】したがって、本発明の燃料電池用ガスセパレータを用いて構成した燃料電池、および本発明の燃料電池によれば、ガスセパレータ表面に設けられた単セル内ガス流路全体に対して、単一のガスマニホールドから一度にガスが供給される場合に比べて、単セル内ガス流路の単位断面積あたりに通過するガスの流量が増大し、流速が速まるため、流路内でのガスの拡散性が向上し、ガス中の電極活物質が電極上に設けられた触媒に到達しやすくなる。したがって、電極活物質が電気化学反応で利用されやすくなってガスの利用率が向上するため、燃料電池に供給すべきガス量を抑えることができるという効果を奏する。

【0018】さらに、単セル内ガス流路におけるガスの流速が速まることによって、特に酸素を含有する酸化ガスの流路においては、流路内の排水性を向上させることができるという効果を奏する。燃料電池において電気化学反応が進行するときには、酸化ガスが供給されるカソード側では生成水が生じ、この生成水は酸化ガス中に気化して燃料電池外に排出されるが、酸化ガス中に気化できずに生成水が滞留すると、ガスの拡散を妨げるようになるおそれがある。単セル内ガス流路における酸化ガスの流速を速めることによって、生成水が酸化ガス中に気化するのを促し、生成水が滞留してガスの拡散を妨げるのを防止することができる。

【0019】また、燃料電池に供給すべきガスの総量を減らすことができることから、燃料電池に供給する酸化ガスに対する加湿量を減らすことができるという効果も得られる。固体高分子型燃料電池では、カソード側で生じる既述した生成水を含めて、電解質膜が保持する水分の一部は、酸化ガス中に気化して燃料電池外に排出されるため、通常は、燃料電池に供給する酸化ガスをあらかじめ加湿して、電解質膜の乾燥を防いでいる。上記したように燃料電池に供給する酸化ガスの総量を減らすことができると、酸化ガスによって燃料電池外に持ち出される水分量をより少なくすることができ、燃料電池に供給する酸化ガスの加湿量を低減できる。これによって、酸化ガスを加湿するために消費するエネルギ量を削減することができる。燃料電池に供給する燃料ガスとして、炭化水素を水蒸気改質して得た改質ガスを用いる場合には、燃料ガスを加湿する特別な構成は不要であるが、燃料ガスとして水素ガスを用いる場合には、燃料電池に供給するのに先立って加湿する必要がある。このような場合にも、燃料電池に供給すべきガスの総量を減らせることから、加湿量を抑え、加湿のために消費するエネルギ量を削減できるという効果を得ることができる。

【0020】さらに、本発明の燃料電池用ガスセパレータを用いて構成した燃料電池、および本発明の燃料電池によれば、任意の単セルにおいて、酸化ガスあるいは燃料ガスが供給される領域が分割されており、それぞれの領域に対して異なるガスマニホールドからガスが供給されるため、ガスマニホールドと単セル内流路との接続部に凝縮水が滞留する場合にも、単セルに対するガスの供給が完全に絶たれてしまうおそれがない。すなわち、上記した接続部に凝縮水が滞留して所定の単セル内流路に対するガスの供給が遮断されても、ガスセパレータの同一面上に形成される複数の単セル内ガス流路に対応する接続部のすべてが同時に閉塞されてしまう可能性はきわめて低く、スタック構造を構成する単セルのいずれかに対するガスの供給が凝縮水の滞留に起因して停止してしまうのを防止することができる。

【0021】本発明の燃料電池用ガスセパレータにおいて、前記複数の単セル内流路形成部を、その両面に有することとしてもよい。このような構成とすれば、本発明の燃料電池用ガスセパレータを用いて構成した燃料電池において、水素を含有する燃料ガスの流路と、酸素を含有する酸化ガスの流路の両方において、上記したように、ガスの利用率を向上させる効果を得ることができる。

【0022】また、本発明の燃料電池において、前記電極活物質を含有するガスは、酸素を含有する酸化ガスで

あり、それぞれの前記単セルにおいて、前記酸化ガスが流入する前記単セル内ガス流路は、内部を通過する前記酸化ガスの流れの方向が、重力に従う場合と同様に上方から下方へ向かう方向となるように形成されたこととしてもよい。

【0023】このような構成とすれば、酸化ガスが通過する単セル内ガス流路において、排水性をさらに向上させることができる。すなわち、燃料電池における電気化学反応の進行に伴って、カソード側で生じた生成水が、単セル内ガス流路で凝縮してしまった場合にも、単セル内ガス流路での酸化ガスの流れの方向を上方から下方へ向かわせることによって、凝縮水は重力に従って排出されやすくなり、凝縮水が流路内で滞留してガスの流通を妨げてしまうのを防止することができる。

【0024】また、本発明の燃料電池用ガスセパレータにおいて、該燃料電池用ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が同一の方向を向き、かつ、互いに隣接するように配置されており、複数の前記単セル内流路形成部がそれぞれ2つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの辺縁部に沿って、互いに隣接するように配置されていることとしてもよい。

【0025】同様に、本発明の燃料電池において、前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が同一の方向を向き、かつ、互いに隣接するように配置されており、それぞれの前記凹部が形成する前記単セル内ガス流路は、U字形をなす前記凹部の両端部において、前記ガス供給マニホールドおよび前記ガス排出マニホールドと接続し、前記複数の分割流路形成部のそれぞれが備える前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の側面の一つに沿って互いに隣接して配設されることとしてもよい。

【0026】このような本発明の燃料電池用ガスセパレータを用いて構成した燃料電池、および本発明の燃料電池によれば、同種のガスが通過するガス供給マニホールドおよびガス排出マニホールドが、スタック構造の側面に一つに沿って配設されており、同種のガスが通過するガスマニホールド間ではガスのシール性を厳密に確保する必要がないため、ガスマニホールドを形成する領域のシール構造を簡素化することができる。また、単セル内ガス流路を形成する凹部の形状をU字形にすることにより、凹部を直線状に形成してその両端部にガスマニホールドのための孔部を形成する場合に比べて、ガスセパレータ表面のより広い領域を単セル内ガス流路に利用することが可能となり、ガスセパレータおよびこれを用いる燃料電池を小型化することができる。

【0027】このような本発明の燃料電池において、燃料電池内部との間で熱交換することによって、前記電気化学反応に伴って生じる熱を取り除いて、燃料電池内部の温度が非所望の温度に上昇してしまうのを防ぐ冷却液を、その内部に通過させる流路であって、燃料電池内部の所定の複数の位置に設けられた冷却液路と、前記スタック構造の積層方向に形成され、前記冷却液を前記冷却液路に分配する、あるいは、前記各冷却液路を通過した前記冷却液が集合する冷却液マニホールドとを備え、前記冷却液マニホールドは、前記スタック構造を形成する側面の一つに沿って互いに隣接して設けられた前記ガス供給マニホールドおよび前記ガス排出マニホールドの近傍に設けられ、前記ガス供給マニホールドおよび前記ガス排出マニホールドが配設された位置よりも、前記単セル内ガス流路が形成される場所から離れた位置に設けられたこととしてもよい。

【0028】このような構成とすれば、冷却液マニホールドを、前記ガス供給マニホールドおよび前記ガス排出マニホールドが配設された位置よりも、前記単セル内ガス流路が形成される場所から離れた位置に配設するため、燃料電池を所定の方向(ガス供給マニホールドおよびガス排出マニホールドが配設されていない側面間の方向)について効果的に小型化することができる。

【0029】また、本発明の燃料電池用ガスセパレータは、前記複数の単セル内流路形成部を前記燃料電池用ガスセパレータの両面に備え、前記燃料電池用ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が第1の方向を向き、かつ、互いに隣接するように配置されており、前記燃料電池用ガスセパレータの他方の面上に形成される複数の前記凹部は、前記他方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が前記第1の方向とは逆向きの第2の方向を向き、かつ、互いに隣接するように配置されており、前記燃料電池用ガスセパレータの一方の面上に形成された複数の前記単セル内流路形成部がそれぞれ2つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの第1の辺縁部に沿って、互いに隣接するように配置されており、前記燃料電池用ガスセパレータの他方の面上に形成された複数の前記単セル内流路形成部がそれぞれ2つずつ備える前記孔構造は、前記燃料電池用ガスセパレータの第1の辺縁部と対向する第2の辺縁部に沿って、互いに隣接するように配置されていることとしてもよい。

【0030】同様に、本発明の燃料電池において、前記ガスセパレータは、前記複数の凹部を、その両面にそれぞれ有し、前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が第1の方向を向き、かつ、互いに隣接するように配置されており、前記ガスセパレータの他方の面上に形成される複数の前記凹部は、前記他方の面の上方から見て、それぞれ、U字形

をなし、各々のU字形が前記第1の方向とは逆向きの第2の方向を向き、かつ、互いに隣接するように配置されており、前記ガスセパレータの一方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第1の側面に沿って、互いに隣接するように配設され、前記ガスセパレータの他方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第1の側面と対向する第2の側面に沿って、互いに隣接するように配設されていることとしてもよい。

【0031】このような本発明の燃料電池用ガスセパレータを用いて構成した燃料電池、および本発明の燃料電池によれば、上記した構成と同様に、同種のガスが通過するガス供給マニホールドおよびガス排出マニホールドが、スタック構造の側面に一つに沿って配設されているため、ガスマニホールドを形成する領域のシール構造を簡素化することができるとともに、ガスセパレータ表面のより広い領域を単セル内ガス流路に利用することができるため、ガスセパレータおよびこれを用いる燃料電池を小型化することができるという効果を得られる。さらに、ガスセパレータの一方の面上に形成される単セル内ガス流路が連通するガスマニホールドと、ガスセパレータの他方の面上に形成される単セル内ガス流路が連通するガスマニホールドとは、互いに対向する側面に沿って形成されるため、燃料電池において、ガスマニホールドが形成されない側面間の距離を効果的に小さくし、燃料電池全体をより小型化することができる。

【0032】さらに、本発明の燃料電池において、前記分割流路形成部が備える前記ガス供給マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路に対して、前記ガスを同時に供給し、前記分割流路形成部が備える前記ガス排出マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路から同時に排出される前記ガスが集合することとしてもよい。このような構成とすれば、ガスマニホールドの構造を簡素化できる。

【0033】また、本発明の燃料電池において、前記スタック構造の積層方向に形成され、前記ガス供給マニホールドあるいは前記ガス排出マニホールドとして働く複数の管状構造を備え、前記管状構造の少なくとも一つは、内部の所定の位置に、内部を通過するガスの流れを遮断する遮断部を有し、前記遮断部よりも前記ガスの流れの上流側に配設された前記単セルでは、前記遮断部を有する前記管状構造を前記ガス供給マニホールドとして働かせ、前記上流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスが同時に供給され、前記遮断部よりも前記ガスの流れの下流側に配設された前記単セルでは、前記遮断部よりも上流側で前記ガス排出マニホールドとして働いた前記管状構造を前記ガス供給マニホールドとして働かせ、前記下流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスを同時に供給することとしてもよい。

【0034】このような構成とすれば、スタック構造に供給されたガスは、遮断部よりもガスの流れの上流側に配置された単セルが備える単セル内ガス流路に対して、同時に供給される。これら上流側に配置された単セルから排出されたガスは、遮断部よりも上流においてガス排出マニホールドとして働いた管状構造をガス供給マニホールドとして、遮断部よりも下流側に配置された単セルが備える単セル内ガス流路に対して供給される。したがって、スタック構造を構成するすべての単セルが備える単セル内ガス流路に同時にガスを供給する構成に比べて、各単セル内ガス流路に供給されるガス量が増大し、流路内でのガスの流速を速めることができる。このように流路内のガス量を増大させるという効果を、マニホールドを構成する管状構造内に遮断部を設けるという簡単な構成により実現することができる。

【0035】また、本発明の燃料電池において、該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、前記燃料電池に供給される前記ガスは、予め分割された後に複数の前記スタック構造のそれぞれに対して供給されることとしてもよい。このような場合にも、個々のスタック構造は、内部を前記ガスが通過する流路として複数の分割流路形成部を備えているため、それぞれのスタック構造では、単セル内ガス流路を通過するガスの流量が増大することによる既述した効果が得られる。

【0036】あるいは、本発明の燃料電池において、該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、複数の前記スタック構造の内の所定の一つに供給された前記ガスは、該所定のスタック構造が備える複数の前記分割流路形成部を順次通過する途中で、前記所定のスタック構造とは異なる前記スタック構造が備える前記分割流路形成部を経由することとしてもよい。

【0037】このような場合にも、個々のスタック構造は、内部を前記ガスが通過する流路として複数の分割流路形成部を備えているため、それぞれのスタック構造では、単セル内ガス流路を通過するガスの流量が増大することによる既述した効果が得られる。さらに、燃料電池に供給されたガスは、複数のスタック構造が各々備える分割流路形成部を、順次通過するため、予めガスの流れを分割した後に個々のスタック構造にガスを供給する場合に比べて、上流部でガスの流れを分割する数を減らすことができる。これによって、単セル内ガス流路を通過

するガス流量をさらに増大させることができると共に、ガスの流れを分割する精度を向上させることができる。ガスの流れを分割する精度が向上することによって、各スタック構造に供給されるガス量をより均一化し、各スタック構造における出力を均一化することができる。

【００３８】

【発明の実施の形態】以上説明した本発明の構成・作用を一層明らかにするために、以下本発明の実施の形態を実施例に基づき説明する。本発明の第１実施例である燃料電池は、固体高分子型燃料電池であり、単セルを複数積層したスタック構造によって形成されている。図１は、第１実施例の燃料電池を構成するスタック構造１５の基本単位である単セル２０の構成を表わす分解斜視図、図２は、本実施例の燃料電池が備えるセパレータ３０の構成を表わす平面図、図３は、スタック構造１５の外観を表わす斜視図である。最初に、図１ないし図３に基づいて、燃料電池の構成を説明し、次に、この燃料電池におけるガスの流れの様子について説明する。

【００３９】上述したように、本実施例の燃料電池は、固体高分子型燃料電池であって、基本単位である単セル２０を積層したスタック構造１５によって構成されている。図１に示すように、単セル２０は、電解質膜３１，アノード３２、カソード３３，セパレータ３０によって構成されている。

【００４０】ここで、電解質膜３１は、固体高分子材料、例えばフッ素系樹脂により形成されたプロトン伝導性のイオン交換膜であり、湿潤状態で良好な電気伝導性を示す。本実施例では、ナフィオン膜（デュポン社製）を使用した。電解質膜３１の表面には、触媒としての白金または白金と他の金属からなる合金が塗布されている。触媒を塗布する方法としては、白金または白金と他の金属からなる合金を担持したカーボン粉を作製し、この触媒を担持したカーボン粉を適当な有機溶剤に分散させ、電解質溶液（例えば、Ａｌｄｒｉｃｈ　Ｃｈｅｍｉｃａｌ社、Ｎａｆｉｏｎ　Ｓｏｌｕｔｉｏｎ）を適量添加してペースト化し、電解質膜３１上にスクリーン印刷するという方法をとった。あるいは、上記触媒を担持したカーボン粉を含有するペーストを膜成形してシートを作製し、このシートを電解質膜３１上にプレスする構成も好適である。

【００４１】アノード３２およびカソード３３は、共に炭素繊維からなる糸で織成したカーボンクロスにより形成されている。なお、本実施例では、アノード３２およびカソード３３をカーボンクロスにより形成したが、炭素繊維からなるカーボンペーパまたはカーボンフエルトにより形成する構成も好適である。

【００４２】セパレータ３０は、ガス不透過の導電性部材、例えば、カーボンを圧縮してガス不透過とした緻密質カーボンにより形成されている。図２（Ａ），（Ｂ）は、セパレータ３０を両面のそれぞれから見た様子を表わす平面図である。セパレータ３０は、その周辺近くに１０個の孔を備えている。すなわち、セパレータ３０の１辺の近傍には、この辺に沿って隣接する３つの孔である孔部４０，４１，４２が設けられており、この辺に対向する辺の近傍には、同じく隣接する孔部４３，４４，４５が設けられている。また、上記した２辺とは異なる１辺の近傍には、この辺に沿って隣接する２つの孔である孔部５０と孔部５１が設けられており、この辺に対向する辺の近傍には、同じく隣接する孔部５２と孔部５３が設けられている（図２参照）。さらに、セパレータ３０は、その両面に平行に形成された溝状のリブを備えている。

【００４３】ここで、セパレータ３０の片方の面では、孔部４０と、これと対向する孔部４３とを連絡してリブ部５５が、孔部４１と、同じくこれと対向する孔部４４とを連絡してリブ部５６が、孔部４２と、同じくこれと対向する孔部４５とを連絡してリブ部５７が設けられている。また、セパレータ３０の他方の面では、孔部５０と、これと対向する孔部５２とを連絡してリブ部５８が、孔部５１と、これと対向する孔部５３とを連絡してリブ部５９が設けられている。これらの各リブ部は、上記したように互いに平行な溝状構造をなしている。

【００４４】図１に示すように、セパレータ３０が電解質膜３１，アノード３２およびカソード３３と共に積層されて単セル２０を形成し、さらにスタック構造１５を構成するときには、各リブ部は、隣接するガス拡散電極との間でガス流路を形成する。すなわち、孔部４０～４５のうちの対向する２つの孔部を連絡するリブ部５５～５７は、隣接するカソード３３の表面との間に単セル内酸化ガス流路を形成し、孔部５０～５３のうちの対向する２つの孔部を連絡するリブ部５８，５９は、隣接するアノード３２の表面との間に単セル内燃料ガス流路を形成する。

【００４５】単セル２０を積層してスタック構造１５を組み立てたときには、各セパレータ３０が備える孔部４０，４４，４２は、それぞれ、スタック構造１５内部をその積層方向に貫通する酸化ガス供給マニホールド６０，６１，６２を形成する。また、孔部４３，４１，４５は、同じく、スタック構造１５内部をその積層方向に貫通する酸化ガス排出マニホールド６３，６４，６５をそれぞれ形成する。さらに、孔部５２，５１は、同じくスタック構造をその積層方向に貫通する燃料ガス供給マニホールド６６，６７をそれぞれ形成し、孔部５０，５３は、燃料ガス排出マニホールド６８，６９をそれぞれ形成する（図２参照）。スタック構造１５内に形成されたこれらガス流路内でのガスの流れについては、後に詳しく説明する（後述する図６および図７を参照）。

【００４６】以上説明した各部材を備えるスタック構造１５を組み立てるときには、セパレータ３０、アノード３２，電解質膜３１，カソード３３，セパレータ３０の

順序で順次重ね合わせ、所定の数の単セル２０を積層した一方の端部にリターンプレート７０を配置する。さらに、その両端に集電板３６，３７、絶縁板３８，３９、エンドプレート８０，８５を順次配置して図３に示すスタック構造１５を完成する。

【００４７】リターンプレート７０は、セパレータ３０と同様に緻密質カーボンによって形成されている。図４は、リターンプレート７０の形状を表わす説明図である。図４（Ａ）は平面の外観を表わし、図４（Ｂ）は図４（Ａ）における（Ｂ）－（Ｂ）断面の様子を表わす。図４に示すように、リターンプレート７０は、その周辺部近傍に凹部７１，７２，７４および孔部７５，７６，７７，７８を備えており、スタック構造１５を構成する際には、隣接するセパレータ３０と、凹部７１，７２，７４を有する面とが接するように、リターンプレート７０を配設する。凹部７１の断面の様子を図４（Ｂ）に示したが、他の凹部７２，７４も同様の構造を有しており、これらはいずれもリターンプレート７０表面を穿って設けられた窪み構造である。また、孔部７５～７８は、リターンプレート７０を貫通する孔構造である。

【００４８】ここで、リターンプレート７０が備える凹部７１は、スタック構造１５を構成する際には、隣接するセパレータ３０が有する孔部４３および孔部４４と重なり、既述した酸化ガス排出マニホールド６３の一端と、酸化ガス供給マニホールド６１の一端とを連通させる。また、凹部７２は、スタック構造１５を構成する際には、隣接するセパレータ３０が有する孔部４１および孔部４２と重なり、既述した酸化ガス排出マニホールド６４の一端と、酸化ガス供給マニホールド６２の一端とを連通させる。同じく凹部７４は、スタック構造１５を構成する際には、隣接するセパレータ３０が有する孔部５０および孔部５１と重なり、既述した燃料ガス排出マニホールド６８の一端と、燃料ガス供給マニホールド６７の一端とを連通させる。

【００４９】さらに、孔部７５は、セパレータ３０の孔部４０と重なって酸化ガス供給マニホールド６０の一端を開口し、孔部７６は、セパレータ３０の孔部４５と重なって酸化ガス排出マニホールド６５の一端を開口する。また、孔部７７は、セパレータ３０の孔部５２と重なって燃料ガス供給マニホールド６６の一端を開口し、孔部７８は、セパレータ３０の孔部５３と重なって燃料ガス排出マニホールド６９の一端を開口する。なお、酸化ガス供給マニホールド６０～６２，酸化ガス排出マニホールド６３～６５、燃料ガス供給マニホールド６６，６７，燃料ガス排出マニホールド６８，６９それぞれの他端は、集電板３７によって閉塞されている。

【００５０】集電板３６，３７は緻密質カーボンや銅板などガス不透過な導電性部材によって形成され、絶縁板３８，３９はゴムや樹脂等の絶縁性部材によって形成され、エンドプレート８０，８５は剛性を備えた鋼等の金属によって形成されている。また、集電板３６，３７にはそれぞれ出力端子３６Ａ，３７Ａが設けられており、スタック構造１５によって構成される燃料電池で生じた起電力を出力可能となっている。なお、集電板３６，絶縁板３８およびエンドプレート８０には、スタック構造１５を構成したときに、リターンプレート７０が備える孔部７５～７８と対応する位置に、これら孔部７５～７８と重なってガス流路を形成可能となる４つの孔構造がそれぞれ設けられている。例えば、エンドプレート８０は、孔部７５～７８のそれぞれに対応して、孔部８１～８４が設けられている（図３参照）。

【００５１】スタック構造１５からなる燃料電池を動作させるときには、エンドプレート８０が備える孔部８３と図示しない燃料ガス供給装置とが接続され、水素リッチな燃料ガスが燃料電池内部に供給される。同様に、燃料電池を動作させるときには、孔部８１と図示しない酸化ガス供給装置とが接続され、酸素を含有する酸化ガス（空気）が燃料電池内部に供給される。ここで、燃料ガス供給装置と酸化ガス供給装置は、それぞれのガスに対して所定量の加湿および加圧を行なって燃料電池に供給する装置である。また、燃料電池を動作させるときには、孔部８４と図示しない燃料ガス排出装置とが接続され、孔部８２と図示しない酸化ガス排出装置とが接続される。

【００５２】スタック構造１５を構成するときの各部材の積層順序は既述した通りであるが、電解質膜３１の周辺部には、セパレータ３０と接する領域において所定のシール部材が設けられる。このシール部材は、各単セル内部から燃料ガスおよび酸化ガスが漏れ出すのを防ぐと共に、スタック構造１５内において燃料ガスと酸化ガスとが混合してしまうのを防止する役割を果たす。

【００５３】以上説明した各部材からなるスタック構造１５は、その積層方向に所定の押圧力がかかった状態で保持され、燃料電池が完成する。スタック構造１５を押圧する構成については、本発明の要部とは関わらないため図示は省略した。スタック構造１５を押圧しながら保持するには、スタック構造１５をボルトとナットを用いて締め付ける構成としても良いし、あるいは所定の形状のスタック収納部材を用意して、このスタック収納部材の内部にスタック構造１５を収納した上でスタック収納部材の両端部を折り曲げて、スタック構造１５に押圧力を作用させる構成としても良い。

【００５４】なお、上記した説明では、セパレータ３０およびリターンプレート７０は、カーボンを圧縮してガス不透過とした緻密質カーボンによって形成することとしたが、異なる材質によって形成することとしてもよい。例えば、焼成体カーボンによって形成したり、金属部材によって形成することとしてもよい。金属部材によって形成する場合には、充分な耐腐食性を有する金属を選択することが望ましい。あるいは、充分な耐腐食性を

有する材質によって、金属部材の表面を被覆することとしてもよい。

【0055】また、図2では記載しなかったが、本実施例のセパレータ30は、酸化ガスが通過するガスマニホールドを形成するための孔部40～45、および、燃料ガスが通過するガスマニホールドを形成するための孔部50～53の他に、冷却水が通過する冷却水マニホールドを形成するための孔部も備えている。燃料電池で進行する電気化学反応では、燃料電池に供給される燃料中の化学エネルギが電気エネルギに変換されるが、化学エネルギから電気エネルギへの変換は完全に行なわれるわけではなく、電気エネルギに変換されなかった残りのエネルギは熱として放出される。このように、燃料電池は発電と共に発熱を続けるため、燃料電池の運転温度を望ましい範囲内とするために、通常は燃料電池内に冷却水の流路を設け、燃料電池内に冷却水を通過させることによって余分な熱を取り除いている。

【0056】既述したセパレータなどの部材を積層してスタック構造15を構成する際には、セパレータ30が備えるこの孔部は、スタック構造15の内部を貫通し、後述する単セル間冷却水流路に対して冷却水を給排する冷却水マニホールドを形成する。このような燃料電池を構成するスタック構造15では、積層された所定数の単セルごとに、通常のセパレータ30の代わりに、冷却水の流路を形成する凹凸構造を表面に形成する冷却水路セパレータを備える（図示せず）。この冷却水路セパレータ上に形成された凹凸構造は、冷却水路セパレータと、これに隣接する部材との間に単セル間冷却水流路を形成する。所定数の単セルごとに配置されたこのスタック内冷却水流路は、上記した孔部からなる冷却水マニホールドから冷却水の給排を受け、この冷却水によって、発電と共に生じた余分な熱を燃料電池内から取り除いている。

【0057】次に、以上のような構成を備えた燃料電池における燃料ガスおよび酸化ガスの流れについて説明する。最初に、酸化ガスについて説明する。図6は、スタック構造15内での酸化ガスの流れを立体的に表わす説明図、図7は、同じく酸化ガスの流れを平面的に表わした説明図である。既述したように、燃料電池外部に設けられた酸化ガス供給装置は、エンドプレート80に設けられた孔部81に接続され、酸化ガス供給装置から供給される酸化ガス（加圧空気）は、絶縁板38および集電板36の対応する位置に設けられた孔部と、リターンプレート70に設けられた孔部75とを介して、酸化ガス供給マニホールド60内に導入される。酸化ガス供給マニホールド60内を通過する酸化ガスは、各単セル20において、各セパレータ30におけるリブ部55と隣接するカソード33との間で形成されるガス流路（単セル内酸化ガス流路）内に導かれる。これら単セル内酸化ガス流路に導かれた酸化ガスは、各単セルにおいて電気化学反応に供されるが、反応に関与しなかった残りの酸化ガスは、セパレータ30に設けられた孔部43によって形成される酸化ガス排出マニホールド63に排出される。酸化ガス排出マニホールド63では、酸化ガス供給マニホールド60とは逆向きに酸化ガスが通過しながら、各単セル内に形成された単セル内酸化ガス流路から排出される酸化ガスと合流する。

【0058】このような酸化ガスは、スタック構造15端部のリターンプレート70に達すると、凹部71によって、さらに酸化ガス供給マニホールド61内に導かれる。酸化ガス供給マニホールド61内に導かれた酸化ガスは、この酸化ガス供給マニホールド61内を通過しながら、各セパレータ30におけるリブ部56と隣接するカソード33との間で形成される各単セル内酸化ガス流路に分配され、この単セル内酸化ガス流路を通過しつつ電気化学反応に供される。このようにして単セル内酸化ガス流路を通過した酸化ガスは、酸化ガス排出マニホールド64に排出され、酸化ガス供給マニホールド61とは逆向きに流れながら合流し、再びリターンプレート70に達する。

【0059】リターンプレート70では、酸化ガスは凹部72に導かれて酸化ガス供給マニホールド62に導入される。酸化ガス供給マニホールド62においても同様に、酸化ガスは、この酸化ガス供給マニホールド62内を通過しながら、各セパレータ30におけるリブ部57と隣接するカソード33との間で形成される各単セル内酸化ガス流路に分配され、この単セル内酸化ガス流路を通過しつつ電気化学反応に供される。このようにして単セル内酸化ガス流路を通過した酸化ガスは、酸化ガス排出マニホールド65に排出されて合流し、酸化ガス供給マニホールド62とは逆向きに流れ、再びリターンプレート70に達する。リターンプレート70に達した酸化ガスは、リターンプレート70の孔部76と、集電板36および絶縁板38の対応する位置に設けられた孔部と、エンドプレート80に設けられた孔部82とを介して、この孔部82に接続する酸化ガス排出装置に排出される。

【0060】以上、スタック構造15内における酸化ガスの流れについて説明したが、スタック構造15内における燃料ガスの流れについても同様である。図8は、スタック構造15内での燃料ガスの流れを平面的に表わした説明図である。既述したように、燃料電池外部に設けられた燃料ガス供給装置は、エンドプレート80に設けられた孔部83に接続され、燃料ガス供給装置から供給される燃料ガスは、絶縁板38および集電板36の対応する位置に設けられた孔部と、リターンプレート70に設けられた孔部77とを介して、燃料ガス供給マニホールド66内に導入される。燃料ガス供給マニホールド66内を通過する燃料ガスは、各単セル20において、各セパレータ30におけるリブ部58と隣接するアノード

32との間で形成されるガス流路（単セル内燃料ガス流路）内に導かれる。これら単セル内燃料ガス流路に導かれた燃料ガスは、各単セルにおいて電気化学反応に供されるが、反応に関与しなかった残りの燃料ガスは、セパレータ30に設けられた孔部50を介して、燃料ガス排出マニホールド68に排出される。燃料ガス排出マニホールド68では、燃料ガス供給マニホールド66とは逆向きに燃料ガスが通過しながら、各単セル内に形成された単セル内燃料ガス流路から排出される燃料ガスと合流する。

【0061】このような燃料ガスは、スタック構造15端部のリターンプレート70に達すると、凹部74によって、さらに燃料ガス供給マニホールド67内に導かれる。燃料ガス供給マニホールド67内に導かれた燃料ガスは、この燃料ガス供給マニホールド67内を通過しながら、各セパレータ30におけるリブ部59と隣接するアノード32との間で形成される各単セル内燃料ガス流路に分配され、この単セル内燃料ガス流路を通過しつつ電気化学反応に供される。このようにして単セル内燃料ガス流路を通過した燃料ガスは、燃料ガス排出マニホールド69に排出され、燃料ガス供給マニホールド67とは逆向きに流れながら合流し、再びリターンプレート70に達する。リターンプレート70に達した燃料ガスは、リターンプレート70の孔部78と、集電板36および絶縁板38の対応する位置に設けられた孔部と、エンドプレート80に設けられた孔部84とを介して、この孔部84に接続する燃料ガス排出装置に排出される。

【0062】以上のように構成された本実施例の燃料電池によれば、それぞれのセパレータ30の表面において、酸化ガスおよび燃料ガスの流路が形成される領域をそれぞれ3および2に分割し、分割した領域のそれぞれに対応して、ガス供給マニホールドおよびガス排出マニホールドを独立して設けているため、燃料電池全体に供給するガス流量が同じであっても、流路が形成される領域を分割しない従来の構成に比べて、単セル内ガス流路における単位断面積当たりのガス流量を増やすと共にガス流速を上昇させることができる。例えば、セパレータ30において、リブ部55、56、57が、単セル内酸化ガス流路を形成可能な領域をそれぞれ3等分している場合には、酸化ガス供給装置から燃料電池に供給する酸化ガスの流量と、セパレータ表面においてリブ部を形成している総面積とが同じであっても、図32に示したセパレータ130を用いる場合に比べて、単セル内酸化ガス流路内を通過する酸化ガスの流量は3倍になる。

【0063】したがって、ガス流路が形成される領域を＊分割することによって、ガス流路内でガスがよく攪拌され、拡散する状態となる。これによって、電極に備えられた触媒と電極活物質とが接触しやすくなり、ガス中の電極活物質を電気化学反応で利用されやすくしてガスの利用率を向上させることができる。ガスの利用率が向上すれば、燃料ガス供給装置あるいは酸化ガス供給装置から燃料電池に供給するガスの総量を従来よりも減らしても、充分に電気化学反応を進行させることが可能となる。したがって、燃料ガスについては、燃料の消費量を抑えることができるという効果が得られる。特に、燃料ガスとして、炭化水素を水蒸気改質法などにより改質して得た改質ガスを用いる場合には有効である。すなわち、改質ガス中には、水素以外の電気化学反応に寄与しない成分が多く含まれるため、充分に電気化学反応を進行させるためには、燃料ガスとして水素ガスを用いる場合に比べて、より多くの水素を含有する改質ガスを燃料ガスとして供給する必要がある。本実施例の構成によってガスの利用率を高めることによって、燃料電池に供給する改質ガス量を抑え、燃料の消費量を削減する効果をより顕著に得ることができる。

【0064】また、燃料電池に供給するガスの総量を抑えることが可能となることによって、酸化ガスについては、酸化ガスを燃料電池に供給する際にこの酸化ガスを加圧するために消費するエネルギ量を抑え、燃料電池を備えるシステム全体のエネルギ効率を高い状態で保つことができるという効果が得られる。ここで、単セル内ガス流路を通過するガス流量を増加させる構成であって、セパレータ表面に形成されるガス流路の形状を一筆書き構造とする既述した構成では、単セル内ガス流路の形状を折り曲げる必要があるため、このガス流路内をガスが通過する際の圧損が大きく、燃料電池に供給するガスの総量が増加しないにも関わらず、燃料電池に供給するガスを加圧するために消費するエネルギ量が増大するという不都合を生じる。本実施例の構成では、単セル内ガス流路を折り曲げる必要がないため、このような圧損の問題が大きくなることもない。

【0065】さらに、ガス流路内を通過するガスの流速を速くすることによって、燃料電池内の排水性を向上させることができるという効果が得られる。ここで、燃料電池における生成水の問題について説明する。燃料電池が、水素を含有する燃料ガスと酸素を含有する酸化ガスとの供給を受けて電気化学反応を進行する際には、生成水が生じる。以下に、燃料電池で進行する電気化学反応を表わす式を示す。

【0066】

$$H_2 \rightarrow 2H^+ + 2e^- \quad \cdots (1)$$

$$(1/2)O_2 + 2H^+ + 2e^- \rightarrow H_2O \quad \cdots (2)$$

$$H_2 + (1/2)O_2 \rightarrow H_2O \quad \cdots (3)$$

【0067】（1）式はアノード側で進行する反応を、（2）式はカソード側で進行する反応を表わし、全体として（3）式に表わす反応が進行する。（2）式に示したように、電気化学反応の進行に伴って、カソード側で

は生成水が生じるが、この生成水は、通常は酸化ガス中に気化して、酸化ガスと共に排出される。このとき、生成水の生成量が多い場合には、生成水が充分に酸化ガス中に気化することができずにガス拡散電極中に滞留し、電解質膜上の触媒近傍におけるガスの拡散を妨げるという不都合を生じる場合がある。本実施例のセパレータ３０を備える燃料電池では、上記したように単セル内ガス流路を通過する酸化ガスの流速が速くなるため、カソード側で生じた生成水が酸化ガス中に効率よく気化されて排出されるため、生成水が燃料電池内部で滞留してガスの拡散を妨げるのを防止することができる。

【００６８】また、燃料電池に供給するガスの総量を減らすことができることによって、燃料電池に供給する酸化ガスに対する加湿量を減らすことができるという効果も得られる。上記したように、カソード側では生成水が生じるが、この生成水を含めて電解質膜が保持する水分の一部は、酸化ガス中に気化して燃料電池外に排出される。燃料電池において充分に電気化学反応を進行させるために、通常は燃料電池に対して、理論的に必要とされる酸素量よりも多くの酸素を含有する酸化ガスを供給するが、燃料電池に供給する酸化ガス量が増えるほど、酸化ガスによって燃料電池内部から持ち出される水分量が増加してしまうため、従来は燃料電池に供給する酸化ガスを予め加湿して、電解質膜の乾燥を防いでいた。本実施例のセパレータ３０を備える燃料電池では、燃料電池に供給するガスの総量を減らすことができるため、酸化ガスによって燃料電池外に持ち出される水分量をより少なくすることができ、燃料電池に供給する酸化ガスの加湿量を低減できるという効果を奏する。加湿量を減らせることによって、加湿に要するエネルギを削減することができる。電解質膜から酸化ガスによって奪われる水分量は、燃料電池の運転温度や、酸化ガスの圧力および流速などによって変わるが、燃料電池に対する加湿を行なわなくても電解質膜が充分な湿潤状態を維持できるならば、酸化ガスの加湿を行なう構成を不要とすることが可能である。なお、アノード側では、（１）式の反応で生じたプロトンは水分子と水和した状態で電解質膜内を移動するため、燃料ガスとして水素ガスを用いる場合には、この燃料ガスを燃料電池に供給するのに先立って加湿する必要があるが、燃料電池に供給する燃料ガス量が抑えられることによって、燃料ガスに対する加湿量も少なくすることができる。

【００６９】ここで、燃料電池に供給するガスの総量を減らし、このようなガスによって電解質膜から奪われる水分量を削減できることによって、燃料電池の運転温度をより高く設定することが可能となるという効果も得られる。すなわち、燃料電池に供給するガス量が減って電解質膜から奪われる水分量が減ることによって、より飽和蒸気圧が高い高温下でも、電解質膜が乾きすぎることなく燃料電池を運転することが可能となる。燃料電池の運転温度をより高く設定することによって、電気化学反応をより活発化することができる。また、燃料電池の運転温度をより高く設定することによって、特に、既述した改質ガスを燃料ガスとして用いる場合には、電解質膜上の触媒が改質ガス中の一酸化炭素によって被毒を受けるのを抑えることができ、電池性能をより向上させることができる。炭化水素を水蒸気改質して水素リッチな改質ガスを生成する際には、微量の一酸化炭素が生成されるおそれがあり、このような一酸化炭素は、電解質膜上の触媒に吸着して触媒性能を低下させる。一酸化炭素による被毒の程度は、温度に依存しており、燃料電池の運転温度をより高く設定することによって、被毒の程度を抑えることができる。

【００７０】また、本実施例のセパレータ３０を備える燃料電池では、任意の単セル２０において、酸化ガスあるいは燃料ガスが供給される領域（単セル内ガス流路が形成される領域）が分割されており、分割された領域のそれぞれに対応して、ガス供給マニホールドおよびガス排出マニホールドが独立して設けられているため、特定のマニホールドと特定の単セル内流路との接続部に生成水が滞留する場合にも、この単セルに対するガスの供給が完全に絶たれてしまうことはなく、単セル全体で発電効率が低下してしまうおそれがないという効果が得られる。上述したように、燃料電池で電気化学反応が進行するときには、そのカソード側で生成水が生じ、生じた生成水は酸化ガス中に気化して排出されるが、燃料電池内部で比較的温度分布状態が低い領域などでは、飽和蒸気圧に対応する水蒸気量を上回る水蒸気量が存在することになって、生成水の凝縮が起きる場合がある。このような生成水の凝縮が起きたときに、この凝縮水がマニホールドと単セル内流路との接続部に滞留してしまうと、この単セル内ガス流路に対するガスの供給が遮断されてしまう。図３２に示したセパレータ１３０のように、セパレータ上に形成される単セル内ガス流路にガスを供給するマニホールドが一カ所の場合には、上記接続部が生成水によって閉塞されると、この接続部に対応する単セルに対するガスの供給が完全に止まってしまう。本実施例のセパレータ３０を備える燃料電池では、セパレータ上に形成される単セル内ガス流路に酸化ガスを供給するマニホールドが独立して３つずつ設けられており、この３つの接続部が同時に閉塞されてしまう可能性はきわめて低く、スタック構造を構成する単セルのいずれかに対する酸化ガスの供給が、生成水に起因して完全に止まってしまうのを防止することができる。

【００７１】さらに、単セル内ガス流路が形成される領域が分割されていることによって、スタック構造１５を構成するそれぞれの単セル２０に供給されるガス量が、燃料電池全体でより均一化されるという効果を奏する。通常、ガス供給マニホールドからそれぞれの単セル内ガス流路に分配されるガスの量は、単セルごとにばらつき

を示す。さらに、それぞれの単セルにおける単セル内ガス流路では、ガス流量の分布がばらつきを示す。すなわち、図32に示したようなセパレータ130を用いて構成した燃料電池では、リブ部155が形成する単セル内ガス流路全体で、ガス流量が均一とはならず、特に、リブ部155の両端部（図32に示したリブ部155の左右の端部付近）においてガス流量が少ない領域が形成される。このように、単セル内ガス流路内で、あるいは、単セル内ガス流路ごとに、ガスの流量にばらつきが生じるため、ガス流量が少ない流路に対応する領域においても充分に電気化学反応が進行するように、通常は、燃料電池全体に供給するガス量を充分な量に設定して、それぞれの単セル内ガス流路に供給されるガス量を充分に確保していた。

【0072】本実施例の燃料電池では、各単セル内で、単セル内ガス流路が形成される領域が分割されているため、分割された個々の領域内（セパレータ30が同一面上に備える複数のリブ部のそれぞれが形成する単セル内ガス流路内）でガスの流量のばらつきが生じるものの、所定の面上に形成された単セル内ガス流路全体では、ガス流量のばらつきの影響をより小さくすることができる。すなわち、分割された個々の領域内におけるガス流量のばらつきは、それぞれ独立して生じ、分割された個々の領域に対しては、それぞれ独立してガスが供給されるため、分割された個々の領域のすべてにおいて、ガスの流量が他の単セル内ガス流路に比べて少なくなる可能性は低く、特定の単セルにおける単セル内ガス流路でガス流量が極端に少なくなるおそれが少なくなる。さらに、図32に示したセパレータ130が形成する単セル内ガス流路のように、広い領域に一度にガスを流す構成は、分割したより狭い領域に別個にガスを供給する構成に比べて、上記したガス流量が少ない領域がはるかに広くなるおそれがある。したがって、本実施例のように単セル内ガス流路を分割することによって、それぞれの単セル内ガス流路において、ガス流量が少なくなる領域をより小さくすることができる。このように、単セル内ガス流路を通過するガスの流量のばらつきを小さくし、ガス流量を充分に確保することができるため、ガス流量のばらつきによりガス流量が少なくなる領域で電気化学反応を充分に進行させるために、燃料電池に対して過剰なガスを供給する必要がなくなり、ガスの消費量を抑えると共に、ガスを燃料電池に供給するために消費するエネルギ量を削減することが可能となる。

【0073】また、燃料電池に供給されたガスは、燃料電池内部を通過する過程で電極活物質が電気化学反応に用いられることによって、含有する電極活物質の濃度が徐々に低下してしまうが、本実施例の燃料電池では、分割された単セル内ガス流路を備えるガス流路が順次接続されており、特定の単セルにだけ、電極活物質濃度が低いガスが供給されてしまうことがない。本実施例のように単セル内ガス流路を形成する領域を分割する代わりに、燃料電池を構成するスタック構造を複数個に分割し、分割したスタック構造を直列に接続する構成としても、燃料電池に供給するガス量が一定の条件で、単セル内ガス流路を通過するガス量を増大させることができるが、この場合には、分割した単セルごとに発電効率に違いが生じるおそれがある。すなわち、100個の単セルを積層してスタック構造を形成する代わりに、50個の単セルを積層したスタック構造2つを直列に接続すると、燃料電池に供給された所定量のガスは、100分割される代わりに50分割されて各単セル内ガス流路に供給されることになり、ガス流量を増やしてガス利用率を上げる効果を得ることができる。しかしながら、下流側のスタック構造は、上流側に比べて供給されるガス中の電極活物質濃度が低くなると共にガス量全体も少なくなるため、下流側のスタック構造は上流側に比べて電圧が低くなるなどの性能のばらつきが生じるおそれがある。このような上流側のスタック構造と下流側のスタック構造との性能のばらつきは、上流側のスタック構造が備える単セル数を下流側に比べて増やすなどしても、解消することは困難である。本実施例の燃料電池では、特定の単セルにおいて、電極活物質濃度が低いガスが供給されたりガス流量が少なくなることがないため、電池性能が部分的に低下してばらつくおそれがない。

【0074】各単セルにおいて、単セル内ガス流路が形成される領域を複数に分割し、それぞれの領域にガスを供給するガスマニホールドを独立して設けるという本実施例の燃料電池の構成によって得られる効果を、実際に確認した例を以下に示す。図9は、燃料電池からの出力電流密度を一定にしたときの、燃料電池を構成する各単セルにおける電圧のばらつきの様子を表わす説明図である。図9（A）は、本実施例のセパレータ30を用いて構成した燃料電池における電圧のばらつきを表わし、図9（B）は、図32に示したセパレータ130を用いて構成した燃料電池における電圧のばらつきを表わす。図中の左側（入り口側）は、ガス供給装置との接続側であり、右側に向かって順次、単セルの積層方向に従って、各単セルにおける電圧を記載している。

【0075】図9に示すように、本実施例のセパレータ30を用いた燃料電池によれば、燃料電池全体において、各単セルで安定した電圧を得ることができる。これに対して、セパレータ130を用いた燃料電池では、各単セルの出力電圧値が大きくばらついていた。なお、図9において、図9（A）は75℃で燃料電池を動作させた結果を表わし、図9（B）は67℃で燃料電池を動作させた結果を表わす。このように、本実施例のセパレータ30を用いた燃料電池では、その運転温度をより高くしても、電解質膜が乾燥して電池性能が低下してしまうという不都合を生じることがない。

【0076】また、図10は、燃料電池からの出力電流

密度を一定として、燃料電池に供給する酸化ガス（加圧空気）量を段階的に変化させたときの、燃料電池を構成する各単セルにおける出力電圧の様子を経時的に表わしたものである。図10（A）は、本実施例のセパレータ30を用いて構成した燃料電池における電圧の変化の様子を表わし、図10（B）は、図32に示したセパレータ130を用いて構成した燃料電池における電圧の変化の様子を表わす。燃料電池に供給する酸化ガス量は、燃料電池からの出力電流密度に基づいて理論的に必要とされる酸素量の、何倍の酸素を含有する空気を供給したかで表わした。測定開始時には、理論的に必要とされる酸素量の2倍の酸素を含有する空気を供給し（図10中ではS：2と表わした）、所定の時間経過後に、燃料電池に供給する酸化ガス中の酸素量を、理論的に必要とされる酸素量の1．5倍に減少させ（図10中ではS：1．5と表わした）、さらに所定の時間が経過すると、燃料電池に供給する酸化ガス中の酸素量を、理論的に必要とされる酸素量の1．25倍に減少させた。

【0077】図10（A）に示すように、本実施例のセパレータ30を用いて構成した燃料電池では、燃料電池に供給する酸化ガス中の酸素量を、理論的に必要とされる量の2倍から1．25倍にまで減少させても、燃料電池を構成する各単セルからの出力電圧値を安定した状態に保つことができた。これに対して、図32に示したセパレータ130を用いて構成した燃料電池では、燃料電池に供給する酸化ガス中の酸素量が理論的に必要とされる量の2倍であっても、燃料電池を構成する各単セルの出力電圧は大きくばらつき、燃料電池に供給する酸化ガス中の酸素量を理論的に必要とされる酸素量の1．5倍に減少させると、電解質膜の乾きに起因して電圧が急落してしまい、発電を継続することができなかった。

【0078】このように、本実施例のセパレータ30を用いて燃料電池を構成することによって、燃料電池に供給する酸化ガス中の酸素量、すなわち燃料電池に供給する酸化ガス量を大幅に削減可能であることが示された。ここで、従来知られる燃料電池の構成、すなわち図32のセパレータ130を備える燃料電池では、燃料電池を構成する各単セルで充分に安定した出力電圧を保つためには、燃料電池に供給する酸化ガス中の酸素量を、理論的に必要とされる酸素量の4～5倍にする必要があった。なお、図10（A）は、セパレータ30を備える燃料電池を75℃で運転した結果を表わし、図10（B）は、セパレータ130を備える燃料電池を67℃で運転した結果を表わす。このように、本実施例のセパレータ30を用いた燃料電池では、運転温度をより高く設定し、燃料電池に供給する酸化ガス中の酸素量、すなわち供給する酸化ガスの流量をより少なくしても、各単セルからの出力電圧を安定して保つことが可能となる。

【0079】上述したセパレータ30では、任意の単セル20において、単セル内酸化ガス流路が形成されている領域は3つに分割し、単セル内燃料ガス流路が形成されている領域は2つに分割することとしたが、それぞれ異なる数に分割することとしてもよい。単セル内ガス流路が形成されている領域を複数に分割し、それぞれの分割された領域に対してガスを給排するマニホールドを別々に設けることによって、単セル内ガス流路を通過するガスの流速を速め、ガス中の電極活物質を電解質膜上の触媒に到達しやすくして、上記した効果を得ることができる。ここで、単セル内流路が形成されている領域を分割する数を増やすほど、単セル内流路を通過するガスの流速は速くなるが、分割数を増やすことによって流路をガスが通過する際の圧損が増大してしまう。流路をガスが通過する際の圧損が大きくなった場合に、燃料電池に供給するガス量を所定量に確保するには、燃料電池に供給するガスを加圧するために消費するエネルギ量を増やす必要がある。したがって、単セル内流路が形成されている領域を分割する数を増やすことによる効果の大きさと、燃料電池に供給するガスを加圧するために消費するエネルギ量の増加分とを考慮して、全体のエネルギ効率が低下しないように、上記した分割数を設定することが望ましい。また、図1および図2に示したセパレータ30では、単セル内流路が形成されている領域を2つまたは3つに等分することとしたが、それぞれ異なる面積となるように分割してもかまわない。

【0080】また、上述したセパレータ30では、リブ部55～59は平行に形成された溝状に形成したが、異なる形状とすることもできる。その一例として、セパレータ30の変形例であるセパレータ30Aの一方の表面の構成を図5に示す。ここで、セパレータ30Aは、リブ部55～57に対応する構造の形状以外はセパレータ30と共通する構造を有しており、共通する構造には同じ番号を付した。セパレータ30Aには、対向する孔部同士を連絡する構造として凹凸部55A，56A，57Aが設けられている。これら凹凸部55A～57Aは、対向する孔部を連絡して形成された凹面上に、断面四角形の凸部を縦横に配置した構造となっている。その他、対向する孔部を連絡する凹凸構造としては、スタック構造を構成したときに、所定の孔部から、これと対向する孔部に向かってガスが通過する単セル内ガス流路を、隣接するガス拡散層との間で形成可能となる形状を有していればよい。

【0081】また、既述した実施例では、図6ないし図8に示したように、所定の酸化（燃料）ガス供給マニホールドと、これに対応する酸化（燃料）ガス排出マニホールドとでは、内部を通過するガスの流れの方向が逆になっているが、これらのガスマニホールドにおけるガスの流れの方向が同じになる構成としてもよい。このような構成を以下に示す。図11は、セパレータ30を用いて、それぞれの酸化（燃料）ガス供給マニホールドと、これに対応する酸化（燃料）ガス排出マニホールドの内

部を通過するガスの流れが同じになるスタック構造115を構成したときの、酸化ガスの流れの様子を平面的に表わす説明図である。

【0082】スタック構造115は、リターンプレート以外は第1実施例のスタック構造15と共通する構成を有しているため、共通する部材には同じ番号を付して詳しい説明は省略する。スタック構造115では、一方の端部にはリターンプレート90が、他方の端部にはリターンプレート95が配設されている。これらリターンプレート90，95について、積層した単セルと接する側の面から見た様子を表わす平面図を、図12に示す。図12（A）はリターンプレート90を、図12（B）はリターンプレート95を表わす。

【0083】燃料電池外部に設けられた酸化ガス供給装置から供給される酸化ガスは、リターンプレート90に設けられた孔部75を介してスタック構造115内に導入される。この酸化ガスは、セパレータ30の孔部40によって形成される酸化ガス供給マニホールド60内を通過しながら、セパレータ30のリブ部55によって形成される各単セル内酸化ガス流路に分配される。各単セル内酸化ガス流路から排出される酸化ガスは、孔部43によって形成される酸化ガス排出マニホールド63で合流し、酸化ガス供給マニホールド60と同じ方向に流れて、リターンプレート95に達する。

【0084】リターンプレート95には、上記酸化ガス排出マニホールド63の端部と、孔部44によって形成される酸化ガス供給マニホールド61の端部とを接続する凹部171が設けられており、酸化ガスは酸化ガス供給マニホールド61に導入される。この酸化ガスは、リターンプレート90側に向かって酸化ガス供給マニホールド61内を通過しながら、各セパレータ30のリブ部56によって形成される各単セル内酸化ガス流路に分配される。各単セル内酸化ガス流路から排出される酸化ガスは、孔部41によって形成される酸化ガス排出マニホールド64で合流し、酸化ガス供給マニホールド61と同じ方向に流れて、リターンプレート90に達する。

【0085】リターンプレート90には、上記酸化ガス排出マニホールド64の端部と、孔部42によって形成される酸化ガス供給マニホールド62の端部とを接続する凹部72が設けられており、酸化ガスは酸化ガス供給マニホールド62に導入される。この酸化ガスは、リターンプレート95側に向かって酸化ガス供給マニホールド62内を通過しながら、各セパレータ30のリブ部57によって形成される各単セル内酸化ガス流路に分配される。各単セル内酸化ガス流路から排出される酸化ガスは、孔部45によって形成される酸化ガス排出マニホールド65で合流し、酸化ガス供給マニホールド62と同じ方向に流れて、リターンプレート95に達する。リターンプレート95では、セパレータ30の孔部45に対応する位置に、外部の酸化ガス排出装置に接続する孔部176が設けられており、この孔部176を介して酸化ガスが排出される。

【0086】このように、酸化ガス供給マニホールドと、これに対応する酸化ガス排出マニホールドにおいて、ガスの流れの方向が同じとなるように構成しても、第1実施例と同様の効果を得ることができる。また、既述した実施例では、単セル内ガス流路における酸化ガスの流れの方向は、上方から下方へ流れる向きと下方から上方へ流れる向きとが、交互に入れ替わる構成としたが、常に上方から下方へ流れる構成も好ましい。このような構成を第2実施例として以下に示す。

【0087】第2実施例の燃料電池は、既述した実施例と同様にセパレータ30を用いて構成されており、スタック構造の一端にはリターンプレート170が配設されている。このスタック構造では、第1実施例のスタック構造15と同様に、酸化ガス供給マニホールドとこれに対応する酸化ガス排出マニホールドとでは、酸化ガスが通過する際の方向が逆向きとなる。図13は、積層した単セルと接する面から見たリターンプレート170の様子を表わす説明図である。ここで、第1実施例のリターンプレート70と共通する部材には同じ番号を付した。

【0088】第2実施例の燃料電池は、第1実施例と同様に、リターンプレート170の孔部75を介して酸化ガス供給装置から酸化ガスの供給を受ける。この酸化ガスは、セパレータ30の孔部40によって形成される酸化ガス供給マニホールドから、リブ部55によって形成される各単セル内酸化ガス流路に分岐して、セパレータ30の孔部43によって形成される酸化ガス排出マニホールドで合流し、リターンプレート170に戻る。リターンプレート170には、セパレータ30の孔部43と孔部41とを連絡する凹部271が設けられており、酸化ガスは、セパレータ30の孔部41によって形成される酸化ガス供給マニホールドに導入される。

【0089】この酸化ガスは、孔部41によって形成される酸化ガス供給マニホールドから、リブ部56によって形成される各単セル内酸化ガス流路に分岐して、セパレータ30の孔部44によって形成される酸化ガス排出マニホールドで合流し、リターンプレート170に戻る。リターンプレート170には、セパレータ30の孔部44と孔部42とを連絡する凹部272が設けられており、酸化ガスは、セパレータ30の孔部42によって形成される酸化ガス供給マニホールドに導入される。

【0090】この酸化ガスは、孔部42によって形成される酸化ガス供給マニホールドから、リブ部57によって形成される各単セル内酸化ガス流路に分岐して、セパレータ30の孔部45によって形成される酸化ガス排出マニホールドで合流し、リターンプレート170に戻る。リターンプレート170には、孔部45に対応する位置に孔部76が設けられており、酸化ガスは、この孔部76を介して外部の酸化ガス排出装置に排出される。

【００９１】このように、第２実施例の燃料電池では、その内部に配設されたセパレータ３０において上側に形成された孔部４０，４１，４２によって形成されるマニホールドが、単セル内酸化ガス流路に酸化ガスを供給する側のマニホールドであり、下側に形成された孔部４３，４４，４５によって形成されるマニホールドが、単セル内酸化ガス流路から酸化ガスが排出される側のマニホールドとなっている。従って、リブ部５５，５６，５７によって形成される単セル内酸化ガス流路では、常に上方から下方に向かって酸化ガスが流れる。

【００９２】以上のように構成された第２実施例の燃料電池によれば、単セル内酸化ガス流路で常に上方から下方へ酸化ガスが流れるため、単セル内酸化ガス流路における排水性を向上させることができるという効果を奏する。既述したように、燃料電池で電気化学反応が進行する際には、そのよう極側で生成水が生じ、生じた生成水は酸化ガス中に気化して外部に排出されるが、このような生成水が単セル内酸化ガス流路で凝縮してしまう場合がある。凝縮した生成水が水滴を成して流路内で滞留すると、単セル内酸化ガス流路を閉塞してガスの流通を妨げてしまうおそれがあるが、単セル内酸化ガス流路におけるガスの流れの方向を常に上方から下方にすることによって、凝縮水は重力に従って排出されやすくなり、流路内で滞留して上記した不都合を生じるのを防ぐことができる。

【００９３】さらに、スタック構造の所定の位置、例えばリターンプレートなどにおいて、凝縮した生成水を外部に排出するための排水ポートを設けることとしてもよい。これによって、酸化ガス中に気化した状態で排出されなかった生成水を燃料電池外に排出し、凝縮した生成水によって酸化ガスの流れが妨げられるのを防ぐことができる。

【００９４】既述した実施例では、セパレータが備える孔部によって形成されるガス供給マニホールドおよびガス排出マニホールドは、スタック構造の積層方向に沿って、その一端から他端まで貫通して形成されたが、このようなマニホールドにおいて、途中で遮断部を設けて、単セル内ガス流路でのガスの流れの方向を変えることとしても良い。このような構成を、第３実施例として以下に説明する。

【００９５】図１４は、第３実施例の燃料電池を構成するスタック構造３１５内での酸化ガスの流れを平面的に表わす説明図である。第３実施例の燃料電池を構成するスタック構造３１５は、既述したスタック構造１１５とほぼ同様の構造を有しているため、共通する部材については同じ番号を付し、詳しい説明は省略する。第３実施例のスタック構造３１５は、既述した実施例と同様に、セパレータ３０を積層することによって構成されているが、既述した実施例とは異なり、酸化ガス供給マニホールドおよび酸化ガス排出マニホールドにおいて、その途中に遮断部が設けられている。すなわち、スタック構造３１５を構成する所定のセパレータ３０では、孔部４０～４５のうちの所定の孔部が閉塞されており、これによってマニホールド内を通過するガスの流れが遮断される構成となっている。

【００９６】図１４に示すように、セパレータ３０が備える孔部４０～４５はそれぞれ、スタック構造３１５において、マニホールド３６０，３６３，３６１，３６４，３６２，３６５を形成する。上記したように、スタック構造３１５を構成する所定のセパレータ３０において、所定の孔部が閉塞されていることによって、マニホールド３６０，３６３，３６１，３６４，３６２，３６５にはそれぞれ、遮断部９６が形成される。

【００９７】マニホールド３６０は、リターンプレート９０を介して外部の酸化ガス供給装置に接続されているため、遮断部９６よりもリターンプレート９０側では、マニホールド３６０は酸化ガス供給マニホールドとして働き、マニホールド３６３は酸化ガス排出マニホールドとして働く。遮断部９６によってマニホールド３６０内を通過するガスの流れが遮断されると、この遮断部９６よりも下流側のマニホールド、および、これらのマニホールドと連通する単セル内酸化ガス流路において、ガスの流れの方向が変わる。すなわち、マニホールド３６０は酸化ガス排出マニホールドとして働き、マニホールド３６３は酸化ガス供給マニホールドとして働き、リブ部５５によって形成される単セル内酸化ガス流路におけるガスの流れの向きは、遮断部９６よりも上流側に配設された単セル内に形成された単セル内酸化ガス流路（リブ部５５が形成する流路）における酸化ガスの流れの向きとは逆向きになる。

【００９８】さらに、マニホールド３６３にも同様に遮断部９６が設けられており、このマニホールド３６３に設けられた遮断部９６よりも下流側のマニホールド、およびこれらのマニホールドと連通する単セル内酸化ガス流路において、ガスの流れの方向が変わる。すなわち、マニホールド３６０は酸化ガス供給マニホールドとなり、マニホールド３６３は酸化ガス排出マニホールドとなり、リブ部５５によって形成される単セル内酸化ガス流路におけるガスの流れの向きは、リターンプレート９０に隣接する領域に配設された単セル内に形成された単セル内酸化ガス流路（リブ部５５が形成する流路）におけるガスの流れの向きと同じ向きに戻る。

【００９９】マニホールド３６１，３６４，３６２，３６５のそれぞれに設けられた遮断部９６もまた、同様に働く。すなわち、酸化ガス供給マニホールドとして働くマニホールド内を通過する酸化ガスの流れが、遮断部９６によって遮断されると、この遮断部９６よりも下流側では、酸化ガス供給マニホールドと酸化ガス排出マニホールドとが入れ替わり、対応するリブ部が形成する単セル内酸化ガス流路における酸化ガスの流れの向きが逆向

きとなる。

【０１００】以上のように構成した第３実施例の燃料電池によれば、既述した実施例と同様に、単セル内ガス流路を同一面内で分割することによって流路内のガス流量を増加させることができる効果に加えて、以下のような効果を奏することができる。すなわち、ガス供給マニホールドとして働くマニホールド内に遮断部を設けることによって、各単セル内ガス流路を通過するガス流量をさらに増加させて、ガスの利用率を向上させることができる。例えば、セパレータ３０が備える孔部４０が形成するマニホールドに酸化ガスを供給する場合に、本実施例では、酸化ガスが供給される端部から遮断部が設けられた位置までの間に配設された単セルのそれぞれに形成された単セル内酸化ガス流路（リブ部５５が形成する流路）に対して、酸化ガスが分配されるが、マニホールド内に遮断部を設けない燃料電池では、スタック構造を構成するすべての単セルのそれぞれに形成された単セル内酸化ガス流路（リブ部５５が形成する流路）に対して、酸化ガスが分配されることになる。したがって、マニホールドに遮断部を設けることによって、外部から供給されるガス量が一定であっても、単セル内ガス流路を通過するガス量をさらに増やすことができ、上記した効果を得ることができる。

【０１０１】既述したように、燃料電池を構成するスタック構造を複数に分割し、分割したスタック構造を直列に接続することによっても、単セル内ガス流路を通過するガスの流量を増加させることができるが、第３実施例の燃料電池では、ガスマニホールドに遮断部を設ける（所定のセパレータにおいて所定の孔部を塞いでおく）という簡単な構成によって、単セル内ガス流路を通過するガスの流量を増加させることができ、ガス流量を増加させるためにガスの配管を複雑化する必要がない。このような燃料電池では、ガスマニホールド内に設ける遮断部の位置および数を調節することによって、各単セル内ガス流路を通過するガス量を増加させる程度を調節することができる。また、本実施例のように、マニホールドの途中に遮断部を設けると、スタック構造内に形成されたガス流路における流路抵抗が増大する。したがって、遮断部の数や遮断部を設ける位置を調節することによって、スタック構造全体で、流路抵抗を自由に設定することができる。上記実施例では、酸化ガスが通過するマニホールドに遮断部を設ける構成を示したが、同様の遮断部を、燃料ガスが通過するマニホールドに設けることとしても良い。

【０１０２】既述した実施例では、単セル内ガス流路は、対向する位置に設けられたマニホールドを連通させるように形成され、単セル内ガス流路内を通過するガスは一定方向に流れる構成としたが、異なる構成とすることもできる。以下に、このような構成の燃料電池を第４実施例として示す。図１５は、第４実施例の燃料電池を構成するセパレータ４３０の構成を表わす平面図であり、図１６は、第４実施例の燃料電池が備えるリターンプレート４７０の構成を表わす平面図である。第４実施例の燃料電池を構成するスタック構造は、セパレータ３０に代えてセパレータ４３０を備え、リターンプレート７０に代えてリターンプレート４７０を備える以外は、第１実施例のスタック構造１５とほぼ同様の構成を有しているため、共通する構成に関する詳しい説明は省略する。

【０１０３】セパレータ４３０は、その周辺部に、孔部４４０～４４３、４５０～４５３を備えている。ここで、孔部４４０～４４３は、セパレータ４３０の所定の一辺に沿って順次隣接しあって設けられており、孔部４５０～４５３は、孔部４４０～４４３が近傍に設けられた辺とは対向する辺に沿って、順次隣接しあって設けられている。また、セパレータ４３０の一方の面上には、凹部４５５および凹部４５６が設けられている。凹部４５５および凹部４５６は、それぞれ、互いに平行な横向きのＵ字形に形成されている。凹部４５５は、その両端部において、孔部４５０および孔部４５１とそれぞれ連通している。また、凹部４５６は、その両端部において、孔部４５２および孔部４５３とそれぞれ連通している。なお、セパレータ４３０において、図１５に示した面とは反対側の面には、凹部４５５、４５６と同様の２つの凹部が、凹部４５５、４５６とは逆向きのＵ字形に形成されている（図示せず）。この裏面に形成された２つの凹部の一方は、両端部において、孔部４４０および孔部４４１のそれぞれと連通しており、他方の凹部は、両端部において、孔部４４２および４４３のそれぞれと連通している。

【０１０４】このようなセパレータ４３０を用いて構成した燃料電池では、凹部４５５および凹部４５６は、隣接するアノード３２との間で単セル内燃料ガス流路を形成し、上述した裏面に形成された２つの凹部は、隣接するカソード３３との間で単セル内酸化ガス流路を形成する。また、孔部４５０および孔部４５２は、セパレータ４３０を積層して形成するスタック構造内で、単セル内燃料ガス流路に燃料ガスを分配する燃料ガス供給マニホールドを形成し、孔部４５１および孔部４５３は、同じくスタック構造内で、単セル内燃料ガス流路から排出される燃料ガスが集合する燃料ガス排出マニホールドを形成する。同様に、孔部４４０および孔部４４２は、スタック構造内で、単セル内酸化ガス流路に酸化ガスを分配する酸化ガス供給マニホールドを形成し、孔部４４１および孔部４４３は、同じくスタック構造内で、単セル内酸化ガス流路から排出される酸化ガスが集合する酸化ガス排出マニホールドを形成する。

【０１０５】さらに、セパレータ４３０の周辺部には、孔部４５０および孔部４５３の近傍に、それぞれ孔部４５７および孔部４５８が形成されている。これら孔部４

57、458は、セパレータ430を積層して形成するスタック構造内で、既述した冷却水マニホールドを形成する。燃料電池の外部から供給される冷却水は、孔部457によって形成される冷却水マニホールドを介して、既述した単セル間冷却水路に分配され、各単セル間冷却水路から排出される冷却水は、孔部458によって形成される冷却水マニホールドを介して燃料電池外部に導かれる。

【0106】なお、図15では、セパレータ430が備える凹部は平坦な凹面を有しているように表わしたが、実際のセパレータ430が備えるそれぞれの凹部には、図5に示したセパレータ30Aが備える凹凸部のように、凹面から突出して設けられた所定の形状の凸部が複数個設けられている。このような凸部によって、凹部によって形成される単セル内ガス流路を通過するガスが撹拌されると共に、セパレータ430と隣接するガス拡散電極と凸部とが接することによって、ガス拡散電極との間で充分な導電性が確保される。

【0107】リターンプレート470は、孔部475～478、孔部491、492および凹部471、474を備えている。このリターンプレート470は、図7および図8にガスの流れの様子の平面図を示した第1実施例のスタック構造15におけるリターンプレート70と同様に、スタック構造の一端に配設される。リターンプレート470を用いてスタック構造を形成する際には、図16に表わした面が単セルを積層した構造に接するように、リターンプレート470を配設する。図16では、このリターンプレート470が備える孔部475～478、孔部491、492および凹部471、474と、セパレータ430が備える孔部440～443、450～453、457、457および凹部455、456との位置関係（リターンプレート470およびセパレータ430を含む部材を積層して組み立てたスタック構造における、上記孔部および凹部の位置関係）がわかるように、セパレータ430が備える上記孔部および凹部の位置を、リターンプレート470上に点線で示した。

【0108】形成したスタック構造においては、孔部477はセパレータ430における孔部450と、孔部478は隣接するセパレータ430における孔部453と、孔部475はセパレータ430における孔部440と、孔部476はセパレータ430における孔部443と、孔部491はセパレータ430における孔部457と、孔部492はセパレータ430における孔部458と、それぞれ位置的に対応して互いに連通する。また、凹部474は、セパレータ430において孔部451、452が形成される領域を覆って形成されており、スタック構造内で孔部451、452が形成するガスマニホールドを、スタック構造の端部において互いに連通させる。同様に凹部471は、セパレータ430において孔部441、442が形成される領域を覆って形成されており、スタック構造内で孔部441、442が形成するガスマニホールドを、スタック構造の端部において互いに連通させる。

【0109】以下に、セパレータ430およびリターンプレート470を備える燃料電池におけるガスの流れの様子を説明する。本実施例の燃料電池を構成するスタック構造は、図3に示したスタック構造15と同様に、両端部のそれぞれにおいて、集電板、絶縁板およびエンドプレートが配設されている。これら集電板、絶縁板およびエンドプレートには、セパレータ430が備える孔部に対応する位置に孔部が設けられており、このようなエンドプレートの孔部と外部の装置とを接続することによって、既述した実施例と同様に、燃料電池に対して流体を給排することが可能となる。リターンプレート470が備える孔部477は、このリターンプレート470に隣接して配設される集電板、絶縁板およびエンドプレートに設けられた孔部（孔部477が設けられた位置に対応する位置に設けられた孔部）を介して、燃料ガス供給装置と接続される。供給された燃料ガスは、セパレータ430が備える孔部450が形成する燃料ガス供給マニホールドを介して、各単セル内に形成された単セル内燃料ガス流路の一方（凹部455が形成する流路）に分配される。この単セル内燃料ガス流路を通過した燃料ガスは、孔部451が形成する燃料ガス排出マニホールドに集合し、リターンプレート470が備える凹部474によって、孔部452が形成する燃料ガス供給マニホールドに導かれる。この燃料ガス供給マニホールドからさらに、各単セル内に形成されたもう一方の単セル内燃料ガス流路（凹部456が形成する流路）に燃料ガスが分配され、この単セル内燃料ガス流路を通過した燃料ガスは、孔部453が形成する燃料ガス排出マニホールドに集合する。上記集電板、絶縁板およびエンドプレートには、リターンプレート470が備える孔部478が設けられた位置に対応する位置に孔部が設けられており、上記燃料ガス排出マニホールドに集合した燃料ガスは、これらの孔部を介して外部の燃料ガス排出装置に排出される。

【0110】酸化ガスの流路も同様に構成されており、セパレータ430が備える孔部440が形成する酸化ガス供給マニホールドに対して外部から酸化ガスが供給され、各単セル内に形成された単セル内酸化ガス流路の一方に分配される。これらの単セル内酸化ガス流路を通過した酸化ガスは、孔部441が形成する酸化ガス排出マニホールドに集合して、リターンプレート470に設けられた凹部471によって、孔部442が形成する酸化ガス供給マニホールドに導かれる。この酸化ガス供給マニホールドから、さらに、各単セル内に形成された単セル内酸化ガス流路の他方に分配された酸化ガスは、孔部443が形成する酸化ガス排出マニホールドに集合して外部に導かれる。

【０１１１】なお、集電板、絶縁板およびエンドプレートには、リターンプレート４７０が備える孔部４９１，４９２に対応する位置にも、それぞれ孔部が設けられている。このうち、孔部４９１に対応する孔部には、所定の冷却水供給装置が接続され、セパレータ４３０が備える孔部４５７が形成する冷却水マニホールドに冷却水が供給され、供給された冷却水は、この冷却水マニホールドから既述した単セル間冷却水流路に分配される。単セル間冷却水流路を通過した冷却水は、孔部４５８が形成する冷却水マニホールドに集合し、上記孔部４９２に対応する孔部を介して、所定の冷却水排出装置に排出される。

【０１１２】このような第４実施例の燃料電池によれば、単セル内ガス流路を同一面上で複数個に分割して、単セル内ガス流路の断面積を小さくすることによって、単セル内流路でのガスの流量および流速を上げ、燃料電池におけるガスの利用率を向上させるという既述した実施例と同様の効果に加えて、さらに以下のような効果を奏する。すなわち、同一面上で複数個に分割した単セル内ガス流路のそれぞれをU字形に形成することによって、スタック構造の断面積全体のうち、電気化学反応に寄与する領域（以下、集電部と呼ぶ）の面積の割合を高くすることができ、燃料電池全体を小型化することができる。

【０１１３】第１実施例のように直線状に形成された分割された単セル内ガス流路を備える燃料電池において、集電部全体を平行に４分割した場合も、本実施例のようにU字形の単セル内ガス流路を形成するセパレータ４３０を用いて燃料電池を構成する場合も、共に、流路断面積が小さくなる効果は同様に得られ、セパレータの所定の一辺に沿って４つの（マニホールドを形成するための）孔部を設ける必要があるが、本実施例の燃料電池では、上記一辺に対向する辺に沿った領域には孔部を設ける必要はなく、この領域は、上記集電部として利用することができる。換言すれば、分割された直線状の単セル内ガス流路を形成するセパレータにおいて孔部が形成される領域のうちの一方の領域（上記一辺に対向する辺の近傍の領域）が不要となる。また、マニホールドを形成する孔部の一部が不要となることによって、孔部周辺に設けられるシール構造（マニホールド内の気密性を保つための構造）も不要となり、セパレータとシールの構造を簡素化することができる。したがって、燃料電池をより小型に、すなわち、燃料電池の断面積をより小さくすることができる。これによって、セパレータなどの構成部材をより小さくすることができ、その材料費を削減することができる。また、燃料電池が小型化できることにより、この燃料電池を車両用電源として電気自動車に搭載する場合には、車両設計の自由度が向上する。

【０１１４】特に本実施例の燃料電池では、分割された単セル内ガス流路は、燃料ガス側と酸化ガス側とでは、互いに対向する向きのU字形となるように形成している。このような構成とすると、セパレータにおいて、所定の一辺に沿って一方のガスを給排するマニホールドを形成する孔部を設けると、他方のガスを給排するマニホールドを形成する孔部は、上記一辺と対向する辺に沿って形成され、残りの２辺の近傍にはマニホールドを形成するための孔部を設ける必要がない。したがって、燃料電池の形状において、所定の方向を短くすることができる。図１５に示したセパレータ４３０のように、単セル内ガス流路を形成する凹部を、横向きのU字形に形成する場合には、燃料電池を縦方向に短い形状とすることができる。このように燃料電池を縦方向に短い形状とすると、燃料電池を車両用電源として電気自動車に搭載する際に、座席の下に燃料電池を配設する場合には、特に有利となる。

【０１１５】なお、このような燃料電池を構成するセパレータにおいて、既述したように、ガスを給排するマニホールドの他に冷却水を給排するマニホールドも設けられるが、冷却水のマニホールドは、ガスのマニホールドよりも集電部から離れた位置に設けることができるため、冷却水のマニホールドを設けることによって、燃料電池の縦方向を小さくできるという上記した効果が損なわれることはない。すなわち、電気化学反応に直接寄与するガスを充分な効率で各単セルに供給するためには、ガスのマニホールドは、集電部に近い領域に設けることが望ましいが、電気化学反応に直接寄与しない冷却水のマニホールドは、集電部からより遠い領域に設けても差し支えないため、冷却水マニホールドを設ける場合には、ガスマニホールドよりも集電部から遠くに設ければ良く、燃料電池の縦方向を大きくする必要がない。特に、図１５に示したセパレータ４３０を用いて構成した燃料電池のように、集電部の断面の形状を、角を落とした楕円形状とすれば、燃料電池の横方向への広がりを抑えることもできる。すなわち、楕円形状の集電部に沿ってガスマニホールドを設けると、スタック構造の断面の形状が四角形であれば、その角部の近傍に余分のスペースが生じるため、このスペースを利用して冷却水マニホールドを設けることによって、燃料電池の縦方向の短さを維持しつつ、燃料電池が横方向に大きくなるのを抑え、燃料電池全体を小型化できる。なお、集電部全体の形状を楕円形ではなく四角形とし、ガス流路をU字形に形成する場合には、このU字の底部にあたる角部はガスの流れが不十分になりやすく、電気化学反応が充分に進行しないおそれがある。したがって、上記したように集電部を楕円形として角部に相当する集電部の面積を減らしても、電池性能にさほど影響はない。

【０１１６】また、本実施例の燃料電池を構成するセパレータ４３０において、凹部４５５の下流側領域（孔部４５１に近い方の直線領域）は、上流側領域（孔部４５０に近い方の直線領域）に比べて幅が狭く形成されてお

り．同じく凹部456の下流側領域（孔部453に近い方の直線領域）は、上流側領域（孔部452に近い方の直線領域）に比べて幅が狭く形成されている（図15参照）。このようなセパレータ430を備える燃料電池の単セル内ガス流路では、下流ほど流路断面積が小さくなる。燃料電池内では、供給されたガス中の電極活物質が電気化学反応で消費されるのに伴い、ガス流量およびガス中の電極活物質濃度が減少する。したがって、このように下流ほど流路断面積を小さくすることによって、ガス流量が減少してしまうのを補い、燃料電池全体で均一な反応が期待でき、充分な電圧を確保することができる。

【0117】さらに、本実施例の燃料電池は、単セル内ガス流路がU字形に形成されているため、単セル内ガス流路を直線状に形成する場合に比べて、ガス利用率をさらに向上させることができるという効果を奏する。すなわち、ガスが流路の形状に導かれてその流れの向きが逆向きに変わる際に、U字形の底部にあたる領域で乱流が発生し易くなり、ガスがより撹拌されることによってガスの利用率が向上する。

【0118】また、本実施例の燃料電池では、燃料ガス側と酸化ガス側の両方で、単セル内ガス流路の形状を横向きのU字形とし、上方から下方に向かってガスを通過させる構成としたため、ガス流路内で生じる生成水の排水機構を簡素化できるという効果を奏する。例えば、第1実施例のように単セル内酸化ガス流路を鉛直方向に設けた場合には、生じた生成水は単セル内酸化ガス流路に導かれて下方に落下し、下方の3つのマニホールド（酸化ガス排出マニホールド63，65，酸化ガス供給マニホールド61）のそれぞれに溜まる。このような燃料電池では、これらのマニホールドにそれぞれ排水バルブを設けるなどして、生成水を取り除く必要があった。本実施例の燃料電池では、単セル内ガス流路がいずれも横向きのU字形となっているため、生じた生成水は、ガスの流れる圧力と重力とに導かれて、単セル内ガス流路において次第に下流側に導かれる。このように、生成水は、セパレータ430が備える孔部453あるいは孔部443が形成するマニホールドに最終的に導かれるため、これら最も下方に位置するマニホールドだけに排水機構を設ければ足りる。あるいは、これらのマニホールドに導かれた生成水が、ガスの圧力によって充分に燃料電池の外部に排出可能であれば、燃料電池内部に排水機構を設けることなく、さらに構成を簡素化することができる。

【0119】なお、本実施例の燃料電池を構成するセパレータ430では、単セル内ガス流路を形成するためのU字形の凹部を、それぞれの面に2つずつ設けたが、単セル内ガス流路の分割数（同一面上に形成される凹部の数）は2以上としても良い。分割数を増やすことによって流路断面が小さくなり、ガスの流速が早くなることによる効果と、分割数を増やして流路抵抗が増すことにより、ガスを供給する際にガスを加圧するために要するエネルギが増える程度などを考慮し、適宜分割数を決定すればよい。また、セパレータ430において、マニホールドを形成する周辺領域と、集電部を形成する領域とは一体で形成しても別体で形成しても良い。

【0120】また、本実施例の燃料電池および第1実施例の燃料電池では、ガス排出マニホールドを通過したガスは、リターンプレートにおいて、このガス排出マニホールドに隣接して設けられたガス供給マニホールド内に導入される。そのため、ガスを導くためにリターンプレートに設ける凹部が小さくて（短くて）済み、凹部の容積を抑えることができる。ガスがこの凹部内を通過する間は発電に寄与しないが、燃料電池の大きさと供給ガス量を一定とした時に、反応に寄与しないガス量を抑えることによって、発電効率を充分に確保することができる。

【0121】さらに、上記したように、リターンプレートが備える凹部によって、所定のガスマニホールドを通過したガスが隣接するガスマニホールドに導かれる場合には、このリターンプレートの凹部の近傍のガスシール構造を簡素化することができる。すなわち、同種のガスの出入り口が隣接している領域の近傍では、異なるガス（酸素と水素）同士が隣接する場合ほど、厳密に気密性を確保する必要がない。

【0122】既述した実施例では、単一のスタック構造内において、ガスの流路をスタック構造の積層方向に平行に分割し、スタック構造に供給されるガスは、これらの分割した流路内を順次通過する構成としたが、このようなスタック構造を複数個接続して燃料電池を構成し、より多くの電力を確保することとしてもよい。複数のスタック構造からなる燃料電池の構成を、第5実施例として以下に説明する。図17は、4つのスタック構造を備える第5実施例の燃料電池500の構成を表わす説明図であり、図18は、燃料電池500が備える各スタック構造に備えられたセパレータ530の構成を表わす平面図である。燃料電池500は、4つのスタック構造515A、515B、515C、515Dを備え、これらのスタック構造を給排ボックス512によって互いに接続し、これらの構造をケース510内に収納している。ケース510は、4つのスタック構造の全体を覆っているが、図17は、ケース510における一番大きな面の一方を取り除き、ケース510の内部を、この取り除いた面側から見た様子を表わす。燃料電池500が備える各スタック構造は、これが備えるセパレータの構造と、内部におけるガスの流れ方以外は、既述した実施例と共通する構成を有しているため、個々のスタック構造に関する詳しい説明は省略する。

【0123】給排ボックス512は、燃料電池500の中央部に配設された箱状の部材であり、所定の剛性を有する材料、例えばアルミニウムなどによって形成されて

いる。この給排ボックス５１２を挟んで、一方の側にはスタック構造５１５Ａ，５１５Ｂが配設され、もう一方の側にはスタック構造５１５Ｃ，５１５Ｄが配設されている。この給排ボックス５１２は、外部に設けた燃料ガス供給装置、燃料ガス排出装置、酸化ガス供給装置および酸化ガス排出装置と接続されている。また、給排ボックス５１２の内部には、所定の形状の流路が形成されており、この流路によって、外部から供給された燃料ガスおよび酸化ガスを、燃料電池５００が備える各スタック構造に分配すると共に、スタック構造内を通過して排出されたガスを外部に導き、また、各スタック構造間でやり取りされるガスを導く。

【０１２４】また、燃料電池５００には、その両端部において加圧保持機構５１４が設けられており、この加圧保持機構５１４によって、各スタック構造に対して、端部側から給排ボックス５１２側に向かって押圧力を加えて、各スタック構造をケース５１０内で保持している。本実施例の加圧保持機構５１４は、加圧シャフト５０１を備えており、この加圧シャフト５０１は、ケース５１０の端部に設けられた所定の孔構造（図示せず）にねじ込まれ、この孔構造に螺合することでそれぞれのスタック構造に対する加圧力を保持する。また、各スタック構造の一端（ケース５１０の端部側）には、プレッシャープレート５０２が設けられている。加圧シャフト５０１から加えられた押圧力は、このプレッシャープレート５０２を介してスタック構造に伝えられ、ケース内のスタック構造全体が加圧される（図１７参照）。

【０１２５】図１８に示すように、セパレータ５３０には孔部５４０～５４５および孔部５５０～５５５が設けられており、一方の面上には、孔部５４０と５４３とを連通させる凹部５４６と、孔部５４１と５４４とを連通させる凹部５４７と、孔部５４２と５４５とを連通させる凹部５４８とが設けられている（図１８（Ａ）参照）。また、もう一方の面上には、孔部５５０と５５３とを連通させる凹部５５６と、孔部５５１と５５４とを連通させる凹部５５７と、孔部５５２と５５５とを連通させる凹部５５８とが設けられている（図１８（Ｂ）参照）。孔部５４０～５４５は、スタック構造内で、酸化ガスを給排する酸ガスマニホールド５６０～５６５を各々形成し、孔部５５０～５５５は、燃料ガスを給排する燃料ガスマニホールド５８０～５８５を各々形成する（図１８参照）。また、凹部５４６～５４８は、スタック構造内で、単セル内酸化ガス流路を形成し、凹部５５６～５５８は、単セル内燃料ガス流路を形成する。なお、図１８では記載を省略したが、セパレータ５３０が備える凹部５４６～５４８、５５６～５５８は、既述したセパレータ４３０と同様に、単セル内ガス流路を通過するガスを攪拌すると共に隣接するガス拡散電極との間で導電性を確保する所定の形状の凸部を備えている。

【０１２６】燃料電池５００は、燃料ガスの流路に関わるリターンプレートを、それぞれのスタック構造の端部（加圧保持機構５１４が設けられている側の端部）に、１枚ずつ備えている。スタック構造５１５Ａの端部にはリターンプレート５９０Ａが、スタック構造５１５Ｂの端部にはリターンプレート５９０Ｂが、スタック構造５１５Ｃの端部にはリターンプレート５９０Ｃが、スタック構造５１５Ｄの端部にはリターンプレート５９０Ｄが配設されている。図１９ないし図２２は、これらのリターンプレートの構成を表わす平面図であり、いずれも、積層された単セル２０に接する側から（給排ボックス５１２側からプレッシャープレート５０２側に向かって）見た様子を表わす。リターンプレート５９０Ａは凹部５７１および凹部５９１を、リターンプレート５９０Ｂは凹部５７２および凹部５９２を、リターンプレート５９０Ｃは凹部５７４および凹部５９３を、リターンプレート５９０Ｄは凹部５７９および凹部５９４を、その表面に備えている。ここで、凹部５７１，５７２，５７４，５７９は、燃料ガスの流路を形成する構造であり、凹部５９１～凹部５９４は、酸化ガスの流路を形成する構造である。

【０１２７】図１９ないし図２２では、リターンプレート５９０Ａ～５９０Ｄの平面的な構成を表わすと共に、燃料電池５００内でのガスの流れの様子を説明する便宜上、同じスタック構造内に積層されたセパレータ５３０が備える既述した孔部の一部と、各リターンプレートが備える上記凹部との位置関係も併せて示した。ここで、各スタック構造内で、各リターンプレートが備える各凹部に対応して位置するセパレータ５３０の孔部は、図１９ないし図２２のそれぞれにおいて、各リターンプレート上に点線で表わした。すなわち、スタック構造５１５Ａにおいて、リターンプレート５９０Ａが備える凹部５７１は、セパレータ５３０が備える孔部５５１，５５２が形成する燃料ガスマニホールド５８１，５８２を連通させると共に、凹部５９１は、セパレータ５３０が備える孔部５４２，５４３が形成する酸化ガスマニホールド５６２，５６３を連通させる（図１９参照）。同じく、スタック構造５１５Ｂにおいて、リターンプレート５９０Ｂが備える凹部５７２は、セパレータ５３０が備える孔部５５１，５５２が形成する燃料ガスマニホールド５８１，５８２を連通させると共に、凹部５９２は、セパレータ５３０が備える孔部５４２，５４３が形成する酸化ガスマニホールド５６２，５６３を連通させる（図２０参照）。また、スタック構造５１５Ｃでは、リターンプレート５９０Ｃが備える凹部５７４は、セパレータ５３０が備える孔部５５０，５５１が形成する燃料ガスマニホールド５８０，５８１を連通させると共に、凹部５９３は、セパレータ５３０が備える孔部５４２，５４３が形成する酸化ガスマニホールド５６２，５６３を連通させる（図２１参照）。同様に、スタック構造５１５Ｄでは、リターンプレート５９０Ｄが備える凹部５７９

は、セパレータ５３０が備える孔部５５０，５５１が形成する燃料ガスマニホールド５８０、５８１を連通させると共に、凹部５９４は、セパレータ５３０が備える孔部５４２，５４３が形成する酸化ガスマニホールド５６２、５６３を連通させる（図２２参照）。燃料電池５００における各部材の積層の向き、およびガスの流れの様子は、後に詳しく説明する。

【０１２８】なお、燃料電池５００が備える４つのスタック構造のうち、スタック構造５１５Ａと５１５Ｃとは単セル２０の積層の方向が同じであり、スタック構造５１５Ｂと５１５Ｄの積層方向は、これらとは逆向きとなっている。燃料電池５００を構成するスタック構造５１５Ａ～５１５Ｄは、それぞれの両端部に、既述した実施例と同様の集電板を備えている。すなわち、スタック構造５１５Ａの両端には集電板５３６Ａ、５３７Ａが、スタック構造５１５Ｂの両端には集電板５３６Ｂ，５３７Ｂが、スタック構造５１５Ｃの両端には集電板５３６Ｃ、５３７Ｃが、スタック構造５１５Ｄの両端には集電板５３６Ｄ，５３７Ｄが、それぞれ配設されている（図１７参照）。図１７では記載を省略したが、既述した実施例と同様に、これらの集電板は、各スタック構造から電力を取り出すための端子を備えている。以下に、各スタック構造５１５Ａ～５１５Ｄが備える集電板に設けられた端子の接続の様子を説明する。

【０１２９】スタック構造５１５Ａにおいて給排ボックス５１２側端部に設けられた集電板５３７Ａの端子は、給排ボックス５１２を挟んで対峙するスタック構造５１５Ｃにおいて給排ボックス５１２側端部に設けられた集電板５３６Ｃの端子と接続される。また、スタック構造５１５Ｃにおいて加圧保持機構５１４側端部に設けられた集電板５３７Ｃの端子は、隣り合うスタック構造５１５Ｄにおいて加圧保持機構５１４側端部に設けられた集電板５３６Ｄの端子と接続される。スタック構造５１５Ｄにおいて給排ボックス５１２側端部に設けられた集電板５３７Ｄの端子は、給排ボックス５１２を挟んで対峙するスタック構造５１５Ｂにおいて給排ボックス５１２側端部に設けられた集電板５３６Ｂの端子と接続される。

【０１３０】ここで、既述したように、スタック構造５１５Ａ，５１５Ｃとスタック構造５１５Ｂ，５１５Ｄとでは単セル２０の積層の方向が逆向きとなっているため、上記のように各スタック構造端部の接続端子を接続することによって、スタック構造５１５Ａ～５１５Ｄは、スタック構造５１５Ａ、５１５Ｃ、５１５Ｄ、５１５Ｂの順に直列に接続される。スタック構造５１５Ａ～５１５Ｄを上記のように直列に接続すれば、スタック構造５１５Ａにおいて加圧保持機構５１４側端部に設けられた集電板５３６Ａの端子と、スタック構造５１５Ｂにおいて加圧保持機構５１４側端部に設けられた集電板５３７Ｂの端子とが燃料電池５００の出力端子となり、これらの端子から電力を取り出すことができる。

【０１３１】以下に、このような燃料電池５００における燃料ガスの流れの様子を説明する。図２３ないし図２５は、燃料電池５００における燃料ガスの流れの様子を表わす説明図である。図２３ないし図２５では、燃料電池５００全体の燃料ガスの流れの様子を示すと共に、各スタック構造内に形成された単セル内燃料ガス流路における燃料ガスの流れの様子も、各スタック構造の近傍に併せて示した。燃料電池５００全体の燃料ガスの流れの様子としては、燃料電池５００を、図１７と同様の方向から見た状態を示した。単セル内燃料ガス流路における燃料ガスの流れの様子は、それぞれのスタック構造が備えるセパレータ５３０を、リターンプレート５９０Ａ，５９０Ｂが配設された側から、リターンプレート５９０Ｃ，５９０Ｄが配設された側に向かって見た様子に基づいて表わした。なお、このような方向からセパレータ５３０を見ると、燃料ガスの流れに関わる凹部５５６～５５８が形成される面は、スタック構造５１５Ｂ，５１５Ｄでは表側（図２３～図２５で示した側）となるが、スタック構造５１５Ａ，５１５Ｃでは裏側（図２３～図２５で示されない側）となる。従って、図２３～図２５では、スタック構造５１５Ｂ、５１５Ｄにおける単セル内の燃料ガスの流れを表わす際に、凹部５５６～５５８は実線で表わしたが、スタック構造５１５Ａ，５１５Ｃにおける単セル内の燃料ガスの流れを表わす際には、凹部５５６～５５８は破線で表わした。ここで、図２３～図２５で示したこのような凹部５５６～５５８は、図中の説明に関わるものだけを、上記実線および破線で示している。さらに、図２３～図２５では、単セル内燃料ガス流路における燃料ガスの流れの様子を表わすための便宜上、セパレータ５３０が備える酸化ガスの流れに関わる孔部等の記載は省略している。

【０１３２】給排ボックス５１２に対して外部から供給された燃料ガスは、給排ボックス５１２内の流路を介して、スタック構造５１５Ａおよび５１５Ｂに分配される。このとき、外部の燃料ガス供給装置から供給された燃料ガスは、給排ボックス５１２内に形成された流路の形状にしたがって２分割され、ガスの流れの方向を変えることなく、スタック構造５１５Ａ，５１５Ｂそれぞれの上端側であって、燃料電池５００の中央よりに設けられた燃料ガスマニホールドに導かれる。すなわち、外部から供給された燃料ガスは、スタック構造５１５Ａ，５１５Ｂが備えるセパレータ５３０に設けられた孔部５５０が形成する燃料ガスマニホールド５８０内に導かれる（図２３参照）。既述したように、スタック構造５１５Ａと５１５Ｂとでは単セル２０の積層の方向が違うため、燃料ガスが最初に導入されるマニホールドは、どちらのスタック構造においても、孔部５５０が形成する燃料ガスマニホールド５８０となる。スタック構造５１５Ａ，５１５Ｂにおいて、孔部５５０が形成する燃料ガス

マニホールド580に導入された燃料ガスは、孔部550と連通する凹部556が形成する単セル内燃料ガス流路に分配され、その後、孔部553が形成する燃料ガスマニホールド583に集合する。すなわち、スタック構造515Aおよび515Bでは、燃料ガスマニホールド583は燃料ガス排出マニホールドとして働く。

【0133】ここで、スタック構造515Aおよび515Bのそれぞれにおいて、孔部553によって形成される燃料ガスマニホールド583と、スタック構造515Cおよび515Dのそれぞれにおいて、孔部553によって形成される燃料ガスマニホールド583とは、給排ボックス512によって接続されている。したがって、スタック構造515Aおよび515Bにおいて孔部553によって形成される燃料ガスマニホールド583を通過した燃料ガスは、給排ボックス512を介してスタック構造515Cおよび515Dに導かれ、孔部553によって形成される燃料ガスマニホールド583に導かれる。なお、このような接続を行なう際には、スタック構造515A，515Bに形成されたガス排出マニホールドを、スタック構造515C，515Dにおいてこれらと対応する位置に形成されたガスマニホールドに接続する。したがって、スタック構造515Aおよび515Bでは、燃料ガスマニホールド580は燃料ガス供給マニホールドとなり、燃料ガスマニホールド583は燃料ガス排出マニホールドとなるが、スタック構造515Cおよび515Dでは、これらが逆になり、燃料ガスマニホールド580は燃料ガス排出マニホールドとなり、燃料ガスマニホールド583は燃料ガス供給マニホールドとなる。

【0134】スタック構造515C，515Dでは、孔部553が形成する燃料ガスマニホールド583から、凹部556が形成する単セル内燃料ガス流路に燃料ガスが分配され、これらの単セル内燃料ガス流路を通過した燃料ガスは、孔部550が形成する燃料ガスマニホールド580に集合して、加圧保持機構514側の端部に配設されたリターンプレート590C，590Dに至る。ここで、リターンプレート590C，590Dがそれぞれ備える凹部574，579（図21，22参照）は、既述したように、隣接するセパレータ530が備える孔部550および551と重なり、孔部550が形成する燃料ガスマニホールド580と、孔部551が形成する燃料ガスマニホールド581とを連通させる。したがって、燃料ガスマニホールド580を通過してきた燃料ガスは、リターンプレート590C，590Dのそれぞれにおいて、凹部574，579によって、同じスタック構造内の孔部551が形成する燃料ガスマニホールド581に導かれる。（図24参照）。

【0135】スタック構造515C，515Dでは、燃料ガスマニホールド581は燃料ガス供給マニホールドとして働き、燃料ガスマニホールド581に導かれた燃料ガスは、凹部557が形成する単セル内燃料ガス流路に分配されて、これらの単セル内燃料ガス流路を通過した後、孔部554が形成する燃料ガスマニホールド584に集合する。すなわち、スタック構造515C，515Dでは、燃料ガスマニホールド584は、燃料ガス排出マニホールドとして働く。

【0136】ここで、スタック構造515Cおよび515Dのそれぞれにおいて、孔部554によって形成される燃料ガスマニホールド584と、スタック構造515Aおよび515Bのそれぞれにおいて、孔部554によって形成される燃料ガスマニホールド584とは、給排ボックス512によって接続されている。したがって、スタック構造515Cおよび515Dにおいて、燃料ガス排出マニホールドである燃料ガスマニホールド584を通過した燃料ガスは、給排ボックス512を介して、スタック構造515Aおよび515Bにおいて、孔部554によって形成される燃料ガスマニホールド584に導かれる。すなわち、スタック構造515A，515Bでは、燃料ガスマニホールド584は、燃料ガス供給マニホールドとして働く（図24参照）。

【0137】スタック構造515A，515Bでは、孔部554が形成する燃料ガスマニホールド584から、凹部557が形成する単セル内燃料ガス流路に燃料ガスが分配され、これらの単セル内燃料ガス流路を通過した燃料ガスは、孔部551が形成する燃料ガスマニホールド581に集合して、加圧保持機構514側の端部に配設されたリターンプレート590A，590Bに至る。すなわち、スタック構造515A，515Bでは、燃料ガスマニホールド581は、燃料ガス排出マニホールドとして働く。

【0138】ここで、リターンプレート590A，590Bがそれぞれ備える凹部571，572（図19，20参照）は、既述したように、隣接するセパレータ530が備える孔部551および孔部552と重なり、孔部551が形成する燃料ガスマニホールド581と、孔部552が形成する燃料ガスマニホールド582とを連通させる。したがって、燃料ガスマニホールド581を通過してきた燃料ガスは、リターンプレート590A，590Bのそれぞれにおいて、凹部571，572によって、同じスタック構造内の孔部552が形成する燃料ガスマニホールド582に導かれる。（図25参照）。スタック構造515A，515Bでは、燃料ガスマニホールド582は燃料ガス供給マニホールドとして働き、燃料ガスマニホールド582を通過する燃料ガスは、凹部558が形成する単セル内燃料ガス流路に分配されて、これらの単セル内燃料ガス流路を通過した後、孔部555が形成する燃料ガスマニホールド585に集合する。すなわち、スタック構造515A，515Bでは、燃料ガスマニホールド585は、燃料ガス排出マニホールドとして働く。

【０１３９】ここで、スタック構造５１５Ａおよび５１５Ｂのそれぞれにおいて、孔部５５５によって形成される燃料ガスマニホールド５８５と、スタック構造５１５Ｃおよび５１５Ｄのそれぞれにおいて、孔部５５５によって形成される燃料ガスマニホールド５８５とは、給排ボックス５１２によって接続されている。したがって、スタック構造５１５Ａおよび５１５Ｂにおいて、燃料ガス排出マニホールドである燃料ガスマニホールド５８５を通過した燃料ガスは、給排ボックス５１２を介して、スタック構造５１５Ｃおよび５１５Ｄにおいて、孔部５５５によって形成される燃料ガスマニホールド５８５に導かれる。すなわち、スタック構造５１５Ｃ，５１５Ｄでは、燃料ガスマニホールド５８５は、燃料ガス供給マニホールドとして働く（図２５参照）。

【０１４０】スタック構造５１５Ｃ，５１５Ｄでは、孔部５５５が形成する燃料ガスマニホールド５８５から、凹部５５８が形成する単セル内燃料ガス流路に燃料ガスが分配され、これらの単セル内燃料ガス流路を通過した燃料ガスは、孔部５５２が形成する燃料ガスマニホールド５８２に集合して、再び給排ボックス５１２に至る。すなわち、スタック構造５１５Ｃ，５１５Ｄでは、燃料ガスマニホールド５８２は、燃料ガス排出マニホールドとして働く。既述したように、給排ボックス５１２は外部に設けた燃料ガス排出装置と接続しており、燃料ガスマニホールド５８２を通過した燃料ガスは、給排ボックス５１２を介して外部に排出される。

【０１４１】以上、燃料電池５００における燃料ガスの流れの様子について説明したが、次に、燃料電池５００における酸化ガスの流れの様子の説明に先立って、給排ボックス５１２内に設けられた酸化ガスの流路であって、既述したリターンプレートと同様に働く流路について説明する。この酸化ガスの流路は、給排ボックス５１２内において、各スタック構造と接する領域の近傍に設けられている。図２６は、図１７に示したＥ－Ｅ線において給排ボックス５１２を切断した断面を表わす模式図であり、図２７は、図１７に示したＦ－Ｆ線において給排ボックス５１２を切断した断面を表わす模式図である。図２６，２７に示すように、給排ボックス５１２には、流路５１６～５１９が設けられており、これらの流路は、各スタック構造において、所定の酸化ガスマニホールド間を連通させるために働く。

【０１４２】図２６，２７では、流路５１６～５１９に加えて、これらの流路によって連通される酸化ガスマニホールドを形成する孔部（セパレータ５３０に設けられた孔部）の対応する位置も併せて示した。ここで、セパレータ５３０が備える孔部の位置は、図２６，２７では、破線によって示した。図２６に示すように、流路５１６は、スタック構造５１５Ａにおいて、孔部５４０が形成する酸化ガスマニホールド５６０と孔部５４４が形成する酸化ガスマニホールド５６４とを連通させる。また、流路５１７は、スタック構造５１５Ｂにおいて、孔部５４０が形成する酸化ガスマニホールド５６０と孔部５４４が形成する酸化ガスマニホールド５６４とを連通させる。同様に、図２７に示すように、流路５１８は、スタック構造５１５Ｄにおいて、孔部５４０が形成する酸化ガスマニホールド５６０と孔部５４４が形成する酸化ガスマニホールド５６４とを連通させ、流路５１７は、スタック構造５１５Ｃにおいて、孔部５４０が形成する酸化ガスマニホールド５６０と孔部５４４が形成する酸化ガスマニホールド５６４とを連通させる。

【０１４３】以下に、このような燃料電池５００における酸化ガスの流れの様子を説明する。図２８ないし図３０は、燃料電池５００における酸化ガスの流れの様子を表わす説明図である。図２８ないし図３０では、燃料電池５００全体の酸化ガスの流れの様子を示すと共に、各スタック構造内に形成された単セル内酸化ガス流路における酸化ガスの流れの様子も併せて示した。燃料電池５００全体の酸化ガスの流れの様子は、燃料電池５００を、スタック構造５１５Ｂ，５１５Ｄが配設された側から、スタック構造５１５Ａ，５１５Ｃが配設された側に向かって見た様子に基づいて表わした。単セル内酸化ガス流路における酸化ガスの流れの様子は、それぞれのスタック構造が備えるセパレータ５３０を、リターンプレート５９０Ａ，５９０Ｂが配設された側から、リターンプレート５９０Ｃ，５９０Ｄが配設された側に向かって見た様子に基づいて表わした。なお、このような方向からセパレータ５３０を見ると、酸化ガスの流れに関わる凹部５４６～５４８が形成される面は、スタック構造５１５Ａ，５１５Ｃでは表側（図２８～図３０で示した側）となるが、スタック構造５１５Ｂ，５１５Ｄでは裏側（図２８～図３０で示されない側）となる。従って、図２８～図３０では、スタック構造５１５Ａ，５１５Ｃにおける単セル内の酸化ガスの流れを表わす際に、凹部５４６～５４８は実線で表わしたが、スタック構造５１５Ｂ，５１５Ｄにおける単セル内の酸化ガスの流れを表わす際には、凹部５４６～５４８は破線で表わした。ここで、図２８～図３０で示したこのような凹部５４６～５４８は、図中の説明に関わるものだけを、上記実線および破線で示している。さらに、図２８～図３０では、単セル内酸化ガス流路における酸化ガスの流れの様子を表わすための便宜上、セパレータ５３０が備える燃料ガスの流れに関わる孔部等の記載は省略している。

【０１４４】給排ボックス５１２に対して外部から供給された酸化ガスは、給排ボックス５１２内の流路を介して、４つのスタック構造（スタック構造５１５Ａないし５１５Ｄ）に分配される。給排ボックス５１２から分配された酸化ガスは、スタック構造５１５Ａないし５１５Ｄが備えるセパレータ５３０に設けられた孔部５４１が形成する酸化ガスマニホールド５６１内に導かれる（図２８参照）。すなわち、スタック構造５１５Ａないし５

１５Ｄでは、酸化ガスマニホールド５６１は、酸化ガス供給マニホールドとして働く。酸化ガスマニホールド５６１に導入された酸化ガスは、凹部５４７が形成する単セル内酸化ガス流路に分配されて、単セル内酸化ガス流路を上方から下方に向かって流れ、その後、孔部５４４が形成する酸化ガスマニホールド５６４に集合する。すなわち、スタック構造５１５Ａないし５１５Ｄでは、酸化ガスマニホールド５６４は、酸化ガス排出マニホールドとして働く。

【０１４５】ここで、酸化ガスマニホールド５６４に集合した酸化ガスは、再び給排ボックス５１２に戻る。給排ボックス５１２には、既述したように、孔部５４４が形成する酸化ガスマニホールド５６４と、孔部５４０が形成する酸化ガスマニホールド５６０とを、同じスタック構造内で接続する流路５１６～５１９が形成されている。したがって、それぞれのスタック構造において、酸化ガスマニホールド５６４を通過した酸化ガスは、給排ボックス５１２が備える流路５１６～５１９によって、同じスタック構造内で孔部５４０が形成する酸化ガスマニホールド５６０に導入される（図２９参照）。すなわち、スタック構造５１５Ａないし５１５Ｄでは、酸化ガスマニホールド５６０は、酸化ガス供給マニホールドとして働く。各スタック構造では、酸化ガスマニホールド５６０を通過する酸化ガスは、凹部５４６が形成する単セル内酸化ガス流路に分配され、その後、孔部５４３が形成する酸化ガスマニホールド５６３に集合する。すなわち、スタック構造５１５Ａないし５１５Ｄでは、酸化ガスマニホールド５６３は、酸化ガス排出マニホールドとして働く。

【０１４６】孔部５４３が形成する酸化ガスマニホールド５６３に集合した酸化ガスは、それぞれのスタック構造において、加圧保持機構５１４側の端部に配設されたリターンプレート５９０Ａないし５９０Ｄに至る。ここで、リターンプレート５９０Ａないし５９０Ｄがそれぞれ備える凹部５９１ないし５９４（図１９ないし図２２参照）は、既述したように、各スタック構造内でセパレータ５３０が備える孔部５４３および孔部５４２と重なり、孔部５４３が形成する酸化ガスマニホールド５６３と、孔部５４２が形成する酸化ガスマニホールド５６２とを連通させる。したがって、リターンプレート５９０Ａないし５９０Ｄのそれぞれにおいて、酸化ガスマニホールド５６３を通過してきた酸化ガスは、凹部５９１ないし５９４によって、同じスタック構造内で、孔部５４２が形成する酸化ガスマニホールド５６２に導入される（図３０参照）。スタック構造５１５Ａないし５１５Ｄでは、酸化ガスマニホールド５６２は酸化ガス供給マニホールドとして働き、酸化ガスマニホールド５６２に導入された酸化ガスは、凹部５４８が形成する単セル内酸化ガス流路に分配されて、これらの単セル内酸化ガス流路を通過した後、孔部５４５が形成する酸化ガスマニホールド５６５に集合する。すなわち、スタック構造５１５Ａないし５１５Ｄでは、酸化ガスマニホールド５６５は、酸化ガス排出マニホールドとして働く。酸化ガスマニホールド５６５に集合した酸化ガスは、再び給排ボックス５１２に至る。既述したように、給排ボックス５１２は、外部に設けた酸化ガス排出装置と接続しており、酸化ガスマニホールド５６５を通過した酸化ガスは、給排ボックス５１２を介して外部に排出される。

【０１４７】なお、上記した燃料電池５００に関する実施例では説明を省略したが、燃料電池５００を構成する各スタック構造には、内部温度を所定の温度以下に保つための冷却水を循環させる流路も形成されている。このような冷却水もまた、給排ボックス５１２を介して外部から供給され、給排ボックス５１２によって４つのスタック構造のそれぞれに分配され、各スタック構造の内部を通過した後、給排ボックス５１２を介して外部に排出される。

【０１４８】また、本実施例の燃料電池５００が備えるセパレータ５３０では、第４実施例の燃料電池が備えるセパレータ４３０同様に、より下流側の単セル内ガス流路を形成する凹部ほど流路断面を細く形成した。すなわち、燃料ガスの流路側では、凹部５５６、５５７、５５８の順に流路断面積が小さくなり、酸化ガスの流路側では、凹部５４７、５４６、５４８の順に流路断面積が小さくなる。これによって、供給されるガスの総量が少なくなる下流側においても、単位流路断面積当たりのガス流量が確保され、充分に早い流速を確保することができる。

【０１４９】以上のように構成された第５実施例の燃料電池５００によれば、それぞれのスタック構造内のガス流路を複数に分割し、分割したガス流路に対して順次ガスを供給するため、流路の単位断面積あたりに通過するガス流量が増え、ガスの利用率が向上するなどの既述した実施例と同様の効果が得られる。特に、本実施例の燃料電池は、複数のスタック構造を備え、燃料電池全体が備える単セル数が多いため、ガスの流速を速めてガス利用率を向上させる効果を顕著に得ることができる。通常は、燃料電池が備える単セル数が多い場合には、流速を上げてガスの利用率を向上させるために、ガス供給装置から燃料電池へのガス供給量を増やしても、個々の単セル内ガス流路におけるガス流量の増加分は僅かとなり、燃料の消費量やガス加圧のために消費するエネルギ量が増えるものの、ガス利用率を向上させる充分な効果を得ることが難しい。すなわち、１００個の単セルからなるスタック構造を４つ備える燃料電池において、供給するガス量を増やしても、個々の単セル内ガス流路におけるガス量の増加分は、理論的には、ガス供給装置において増加させたガス量の４００分の１にしかならない。これに対して、本実施例の燃料電池は、セパレータ上に複数の凹部を形成することによって各スタック構造内の流路

を複数に分割し、分割したガス流路に対して順次ガスを供給しているため、多くの単セルを備えているにもかかわらず、ガス供給装置からの供給ガス量を増やすことなく、単セル内ガス流路を通過するガス量を増加させ、ガス利用率を大きく向上させることができる。

【０１５０】さらに、本実施例の燃料電池は、上記した効果に加えて以下のような効果を奏する。外部から供給された燃料ガスは、まずスタック構造５１５Aおよび５１５Bにのみ分配され、スタック構造５１５Aおよび５１５B内に形成された分割された燃料ガス流路を通過した後に、スタック構造５１５Cおよび５１５Dに供給されるため、４つのスタック構造に同時に燃料ガスを分配する構成に比べて１つのスタック構造あたりに供給される燃料ガスの流量が増え、流路内のガス流速が速まるため、燃料ガスの利用率を向上させることができる。

【０１５１】すなわち、４つのスタック構造に同時に燃料ガスを分配する場合には、各スタック構造には、燃料ガス供給装置から供給される燃料ガスの４分の１ずつが供給されることになるが、本実施例の燃料電池５００では、各スタック構造には、燃料ガス供給装置から供給される燃料ガスの２分の１ずつが供給される。このように、流路内の燃料ガス流量が増えてガスの利用率が向上するため、燃料電池に供給する燃料ガスの総量を削減することもできる。通常は、燃料電池全体で充分に電気化学反応を進行させるために、燃料電池に対しては、理論的に必要なガス量を超える過剰量のガスを供給するが、燃料電池におけるガスの利用率が向上することによって、供給するガス量を減らしても充分に電気化学反応を進行させることが可能となる。このような効果は、燃料電池を電気自動車などの駆動用の電源として用いる場合に特に有利となる。すなわち、燃料電池に供給する燃料ガス量を減らせることによって、電気自動車に搭載した燃料の消費量を減らすことができ、一度の燃料補給で走行可能な距離を伸ばすことができる。

【０１５２】なお、複数のスタック構造に対してガスを供給する際に、一部のスタック構造に対して先にガスを供給し、これら上流側のスタック構造を通過したガスを、残りの下流側のスタック構造に供給する場合には、上流側のスタック構造に供給されるガスの方が、電極活物質の濃度が高くなる、あるいは、供給されるガスの総量が多くなるため、上流側のスタック構造の方が下流側に比べて、充分な電圧を得るために有利となってしまう。しかしながら、本実施例の燃料電池５００では、各スタック構造内の分割された流路をスタック構造間で互いに接続して、スタック構造間で交互にガスを通過させるため、一部のスタック構造だけが一方的に下流側に配されることがなく、燃料電池全体で出力を均一化することができる。

【０１５３】さらに本実施例の燃料電池５００によれば、燃料ガス供給装置から供給される燃料ガスを分割する際には、給排ボックス５１２を用いて、ガスの方向を変えずにガスを２分割してスタック構造５１５A、５１５Bに供給しているため、各スタック構造に供給されるガス量をより均一化することができる。すなわち、ガスの流れの方向を変えずにガスを精度良く２分割することは、ガスを異なる方向に４分割するのに比べて、技術的にはるかに容易であるため、各スタック構造に供給されるガス量をより均一化することができ、これによって、燃料電池全体で出力をより均一化することができる。

【０１５４】なお、上記した第５実施例の燃料電池５００では、既述したように、酸化ガスは給排ボックス５１２において４分割し、それぞれのスタック構造に対して別個に供給することとした。ここで、燃料ガスとしてメタノールなどを改質して得た改質ガスを用いる場合には、燃料ガス中の水素濃度は約６０％前後となるが、酸化ガスとして空気を用いる場合には、酸化ガス中の酸素濃度は約２０％となるため、カソード側に充分な酸素を供給するには、燃料ガスに比べてより多くの酸化ガスを燃料電池に供給する必要がある。本実施例の燃料電池における燃料ガスの流路のように、スタック構造内で分割された流路を２つのスタック構造間で互いに接続し、燃料ガスは、双方のスタック構造内を交互に通過する場合には、ガス流路の長さがより長くなって流路抵抗が増し、ガスが流路を通過する際に圧損が大きくなってしまう。したがって、各スタック構造に対して別個にガスを供給する場合に比べて、酸化ガスを供給する際に酸化ガスを加圧するのに要するエネルギ量が大きくなってしまい、燃料電池全体のエネルギ効率が低下する。本実施例の燃料電池５００では、より多くのガスを供給する必要がある酸化ガスの流路において、流路長が長くなってエネルギ効率を低下させてしまうのを避けるために、酸化ガスは各スタック構造に別個に供給することとした。

【０１５５】もとより、エネルギ効率の低下の程度が許容範囲内であれば、酸化ガスの流路側においても、燃料ガスの流路側と同様に、スタック構造内で分割された流路を２つのスタック構造間で互いに接続し、双方のスタック構造内を酸化ガスが交互に通過する構成としてもよい。このような場合には、酸化ガスの流路側においても、ガス流路内のガス流量およびガス流速を増加させ、ガスの利用率を向上させる効果を得ることができる。

【０１５６】さらに、本実施例の燃料電池５００によれば、複数のスタック構造を一つのケース内に収納しているため、全体の構成をコンパクト化することができる。特に、中央部には給排ボックス５１２を設けており、この給排ボックス５１２を介して、外部からガスの供給を受けると共に外部に対してガスを排出し、また、この給排ボックス５１２を介して、各スタック構造間でガスのやり取りをするため、ガスの配管構造をきわめてコンパクトにすることができる。

【０１５７】また、本実施例のように、セパレータ表面

に複数の凹部を設け、それぞれの凹部が独立して単セル内ガス流路を形成し、それぞれの単セル内ガス流路に対応する分割されたガス流路を互いに接続して、これらの間で順次ガスを通過させる際に、ガスは、セパレータの端部に設けた凹部が形成する単セル内ガス流路から順次通過させる必要はない。本実施例では、酸化ガスは、セパレータ５３０の中央部に設けた凹部５４７が形成する単セル内酸化ガス流路から通過させることとした。ガス流路では上流側ほどガス圧が高く、ガス圧が高い流路では、ガス拡散電極を介して周りの領域にガスが若干漏れ出すと考えられるが、このようにセパレータの中央部に設けられた凹部が形成する単セル内ガス流路を上流側とすれば、この上流側の単セル内ガス流路から漏れ出したガスは、両側に配設されたより下流の単セル内ガス流路に対応する領域において利用可能となる。ここで、各単セル内酸化ガス流路では、常に酸化ガスが上方から下方に向かって流れるため、流路内に生じる生成水は、ガスの流れによって下方の酸化ガス排出マニホールドに導かれ、流路を塞いでしまうことがない。酸化ガス排出マニホールドに導かれた生成水は、各酸化ガス排出マニホールドに排水バルブなどを設けることによって、取り除けばよい。

【０１５８】なお、本実施例では、燃料ガスの流路は、セパレータの端部に設けた凹部が形成する単セル内ガス流路から順次通過させることとした。すなわち、上端部の凹部５５６が形成する単セル内燃料ガス流路が最も上流側となり、下方に設けられた凹部が形成する単セル内燃料ガス流路ほど下流側となるように形成した。それぞれの単セル内燃料ガス流路では、燃料ガスは水平方向に流れるため、このような構成とすることで、流路内に生じた生成水は、ガスの流れによって次第に下流側の単セル内燃料ガス流路に導かれ、最終的には最も下流の燃料ガス排出マニホールド（スタック構造５１５Ａ、５１５Ｂでは燃料ガスマニホールド５８５、スタック構造５１５Ｃ、５１５Ｄでは燃料ガスマニホールド５８２）に集まる。したがって、この燃料ガス排出マニホールドに排水バルブなどを設けることによって、容易に生成水を取り除くことができる。

【０１５９】また、第５実施例の燃料電池５００では、給排ボックス５１２内に所定の形状の酸化ガス流路を形成し、この流路によって、より下流側の分割されたガス流路に酸化ガスを導入することとしたが、給排ボックス５１２内に流路を形成する代わりに、各スタック構造の端部にリターンプレートを配設することとしてもよい。すなわち、各スタック構造において、加圧保持機構５１４側の端部に設けられたリターンプレート５９０Ａ～５９０Ｄの他に、給排ボックス５１２側の端部にもそれぞれリターンプレートを設け、これらのリターンプレートによって、給排ボックス５１２内に設けた流路５１６～５１９と同様の動作を実現することとしてもよい。また、第５実施例の燃料電池５００では、各スタック構造は、スタック構造５１５Ａ、５１５Ｃ、５１５Ｄ、５１５Ｂの順で直列に接続することとしたが、異なる接続の仕方をしてもよい。例えば、これらのスタック構造を、互いに並列に接続することとしてもよい。

【０１６０】既述したように、第５実施例の燃料電池５００では、セパレータ上に複数の凹部を形成することによって各スタック構造内の流路を複数に分割し、分割したガス流路に対して順次ガスを供給しているため、多くの単セルを備えているにもかかわらず、ガス供給装置からの供給ガス量を増やすことなく、単セル内ガス流路を通過するガス量を増加させ、ガス利用率を大きく向上させることができた。このような効果を利用して、第５実施例と同様に複数の凹部を備えるセパレータを用いて、よりスタック構造の数の少ない燃料電池を構成することが可能となる。ここで、一つのスタック構造が備える単セルの数を増やすほど、個々の単セル内ガス流路におけるガス流量は減少し、ガスの利用率は低下してしまう。単セル内ガス流路におけるガス流量を確保しつつスタック構造当たりの単セル数を増やすには、スタック構造に供給するガス量を大きく増加させる必要があり、燃料消費量の増加やガスを加圧するために消費するエネルギ量の増加を伴うため、スタック構造当たりの単セル数を増やすことは、従来困難であった。第５実施例と同様に複数の凹部を備えるセパレータを用いて各スタック構造内の流路を複数に分割し、分割したガス流路に対して順次ガスを供給するならば、上記した不都合を伴うことなくスタック構造当たりの単セル数を増やすことができる。

【０１６１】図３１は、２つのスタック構造を備える燃料電池であって、図１７に示した燃料電池５００と同じ数の単セルを備える燃料電池６００の構成を表わす説明図である。燃料電池６００は、燃料電池５００と同様に、セパレータ５３０を用いて構成されており、スタック構造内の流路を３つに分割しているため、スタック構造当たりの単セル数を増加させても、単セル内ガス流路におけるガス流量を充分に確保することができる。このようにスタック構造当たりの単セル数を増やしてスタック構造の数を減らすことによって、ケース内に複数のスタック構造を納めるために生じるデッドスペースを削減し、燃料電池全体をより小型化することが可能となる。

【０１６２】また、上記した実施例では固体高分子型燃料電池について説明したが、本発明の構成を、異なる種類の燃料電池に適用することもできる。例えば、りん酸型燃料電池や固体電解質型燃料電池などに適用した場合にも、ガス利用率を向上させたり排水性を向上させるなどの同様の効果を得ることができる。

【０１６３】以上本発明の実施例について説明したが、本発明はこうした実施例に何等限定されるものではなく、本発明の要旨を逸脱しない範囲内において種々なる態様で実施し得ることは勿論である。

【図面の簡単な説明】

【図１】スタック構造１５の基本単位である単セル２０構成を表わす分解斜視図である。

【図２】セパレータ３０の構成を表わす平面図である。

【図３】スタック構造１５の外観を表わす斜視図である。

【図４】リターンプレート７０の形状を表わす説明図である。

【図５】セパレータ３０の変形例であるセパレータ３０Ａの構成を表わす平面図である。

【図６】スタック構造１５内での酸化ガスの流れを立体的に表わす説明図である。

【図７】スタック構造１５内での酸化ガスの流れを平面的に表わす説明図である。

【図８】スタック構造１５内での燃料ガスの流れを平面的に表わす説明図である。

【図９】燃料電池を構成する各単セルにおける電圧のばらつきの様子を表わす説明図である。

【図１０】燃料電池に供給する酸化ガス（加圧空気）量を段階的に変化させたときの燃料電池における出力電圧の様子を経時的に表わす説明図である。

【図１１】それぞれの酸化ガス供給マニホールドと、これに対応する酸化ガス排出マニホールドの内部を通過するガスの流れが同じになる燃料電池を構成した様子を平面的に表わす説明図である。

【図１２】リターンプレート９０および９５の形状を表わす説明図である。

【図１３】リターンプレート１７０の形状を表わす説明図である。

【図１４】スタック構造３１５内での酸化ガスの流れを平面的に表わす説明図である。

【図１５】セパレータ４３０の構成を表わす平面図である。

【図１６】リターンプレート４７０の形状を表わす説明図である。

【図１７】４つのスタック構造を備える燃料電池５００の構成を表わす説明図である。

【図１８】セパレータ５３０の構成を表わす平面図である。

【図１９】リターンプレート５９０Ａの構成を表わす平面図である。

【図２０】リターンプレート５９０Ｂの構成を表わす平面図である。

【図２１】リターンプレート５９０Ｃの構成を表わす平面図である。

【図２２】リターンプレート５９０Ｄの構成を表わす平面図である。

【図２３】燃料電池５００において燃料ガスが流れる様子を表わす説明図である。

【図２４】燃料電池５００において燃料ガスが流れる様子を表わす説明図である。

【図２５】燃料電池５００において燃料ガスが流れる様子を表わす説明図である。

【図２６】給排ボックス５１２内に形成された酸化ガスの流路の形状を表わす断面図である。

【図２７】給排ボックス５１２内に形成された酸化ガスの流路の形状を表わす断面図である。

【図２８】燃料電池５００において酸化ガスが流れる様子を表わす説明図である。

【図２９】燃料電池５００において酸化ガスが流れる様子を表わす説明図である。

【図３０】燃料電池５００において酸化ガスが流れる様子を表わす説明図である。

【図３１】２つのスタック構造を備える燃料電池６００の構成を表わす説明図である。

【図３２】従来知られるセパレータ１３０の構成を示す説明図である。

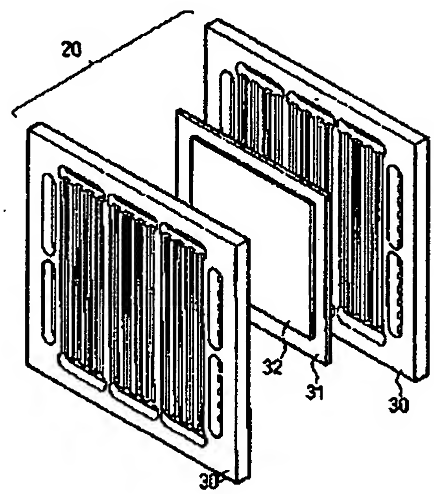
【符号の説明】

１５，１１５，３１５…スタック構造
２０…単セル
３０，３０Ａ，１３０，４３０，５３０…セパレータ
３１…電解質膜
３２…アノード
３３…カソード
３６，３７…集電板
３６Ａ，３７Ａ…出力端子
３８，３９…絶縁板
４０～４５…孔部
５０～５３…孔部
５５～５９…リブ部
５５Ａ～５７Ａ…凹凸部
６０～６２…酸化ガス供給マニホールド
６３～６５…酸化ガス排出マニホールド
６６，６７…燃料ガス供給マニホールド
６８，６９…燃料ガス排出マニホールド
７０，１７０，４７０…リターンプレート
７１，７２，７４…凹部
７５～７８…孔部
８０，８５…エンドプレート
８１～８４…孔部
９０，９５…リターンプレート
９６…遮断部
１４０，１４３…空気孔
１５０，１５２…燃料孔
１５５…リブ部
１７１…凹部
１７６…孔部
２７１…凹部
２７２…凹部
３６０～３６５…マニホールド

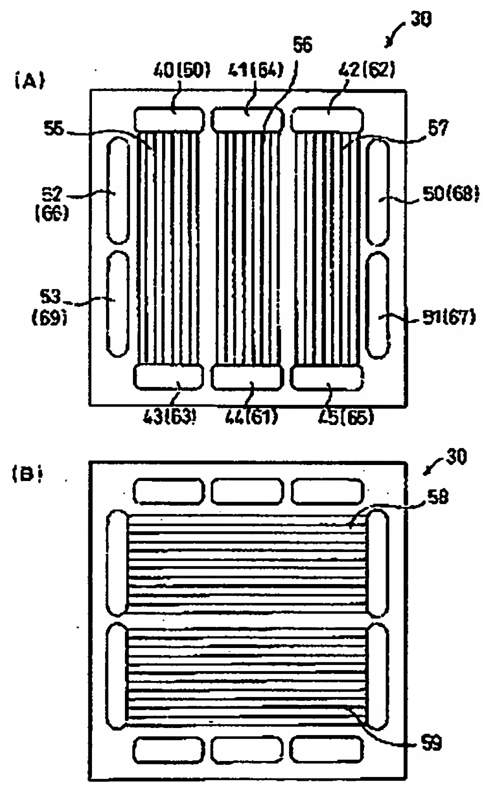
４４０～４４３，４５０～４５３…孔部
４５５，４５６…凹部
４５７，４５８…孔部
４７１，４７４…凹部
４７５～４７８…孔部
４９１，４９２…孔部
５００，６００…燃料電池
５０１…加圧シャフト
５０２…プレッシャープレート
５１０…ケース
５１２…給排ボックス
５１４…加圧保持機構

＊５１５Ａ～５１５Ｄ…スタック構造
５１６～５１９…流路
５３６Ａ～５３６Ｄ，５３７Ａ～５３７Ｄ…集電板
５４０～５４５…孔部
５４６～５４８，５５６～５５８…凹部
５５０～５５５…孔部
５５６～５５８…凹部
５６０～５６５…酸化ガスマニホールド
５７１，５７２，５７４，５７９…凹部
５８０～５８５…燃料ガスマニホールド
５９０Ａ～５９０Ｄ…リターンプレート
＊ ５９１～５９４…凹部

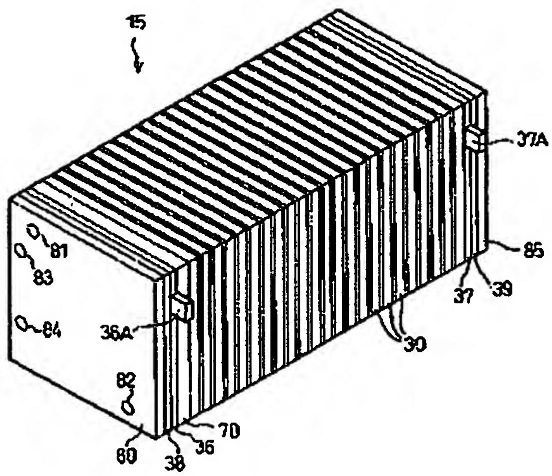
【図１】



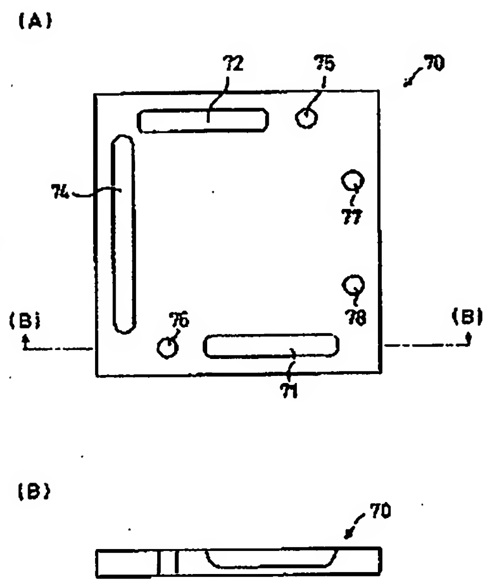
【図２】



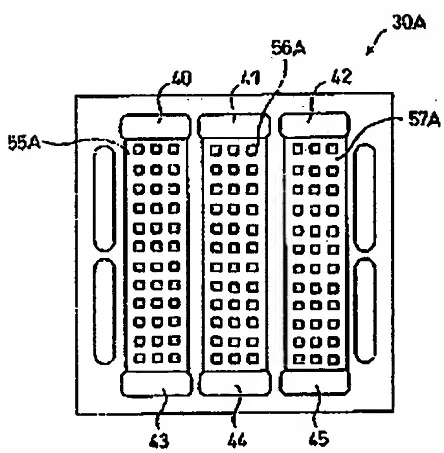
【図3】


15
37A
81
83
85
37
39
84
36A
30
82
70
80
38
36

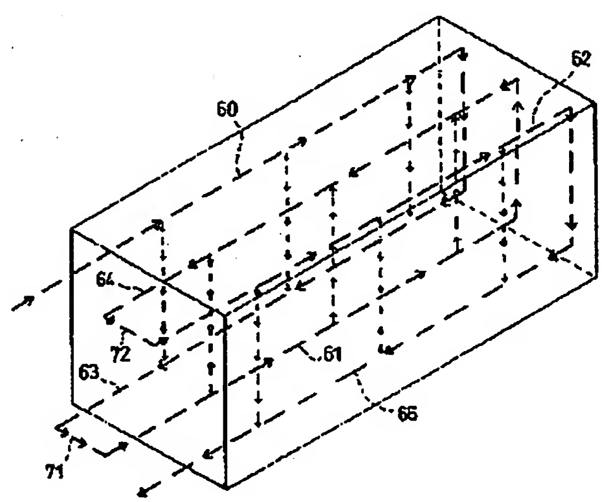
【図4】


(A)
72
75
70
74
77
78
(B)
76
(B)
71
(B)
70

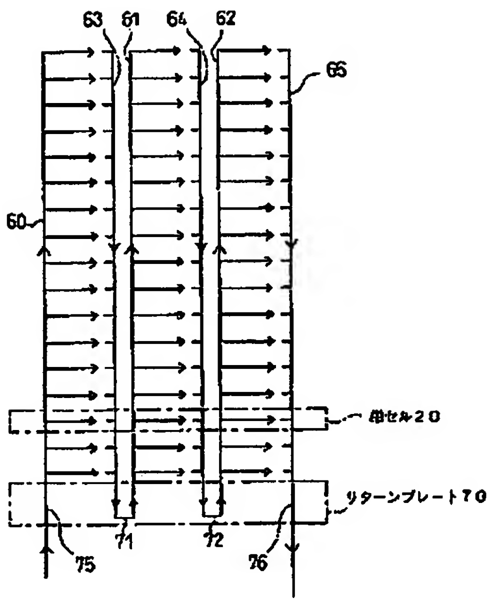
【図5】


30A
56A
40
41
42
57A
55A
43
44
45

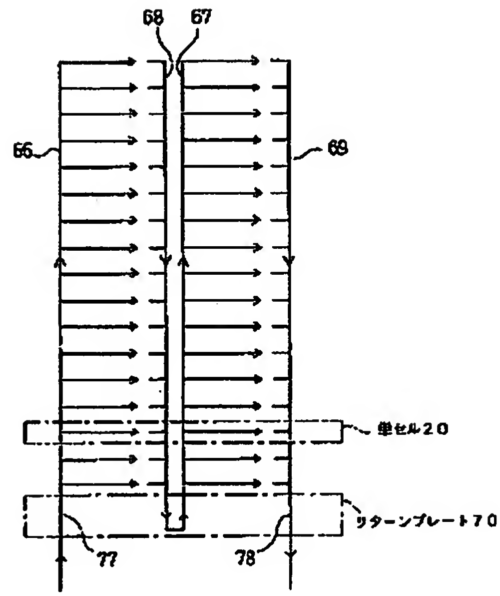
【図6】


62
60
64
72
63
61
65
71

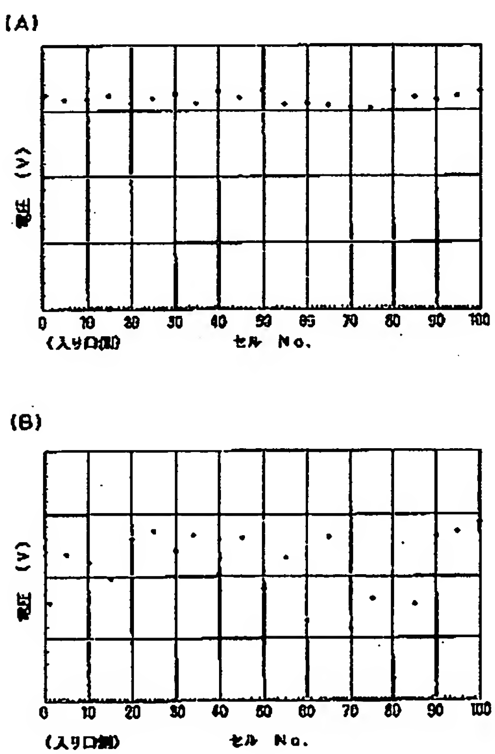
【図7】


63
61
64
62
65
60
単セル20
リターンプレート70
71
72
75
76

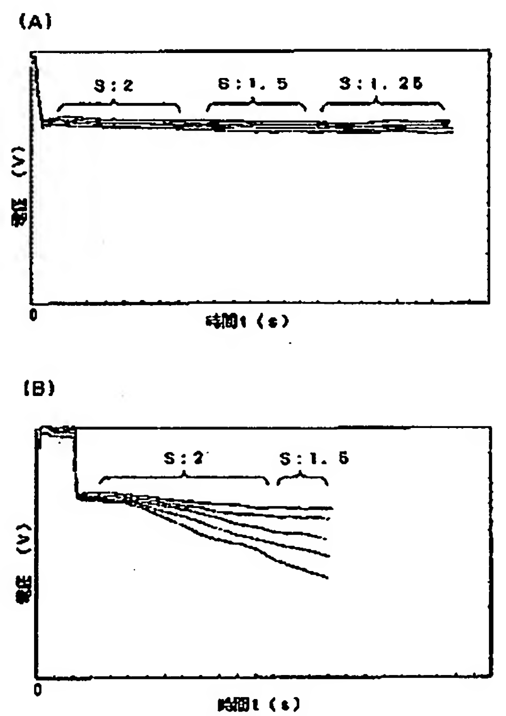
【図8】


68
67
66
69
単セル20
リターンプレート70
77
78

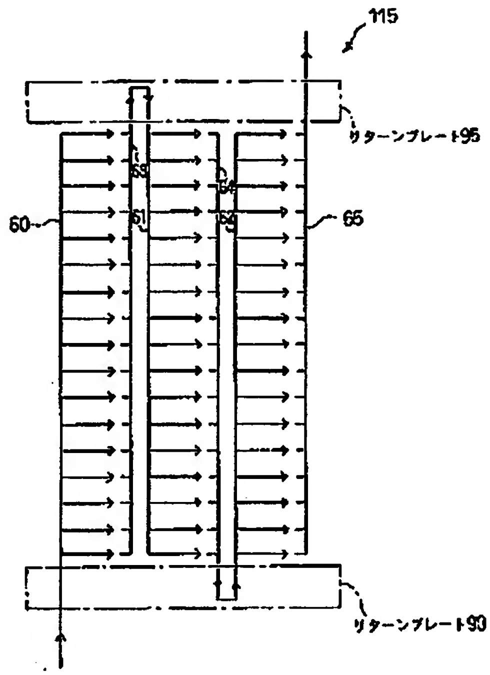
【図9】


(A)
電圧 (V)
0 10 20 30 40 50 60 70 80 90 100
(入り口側)
セル No.
(B)
電圧 (V)
0 10 20 30 40 50 60 70 80 90 100
(入り口側)
セル No.

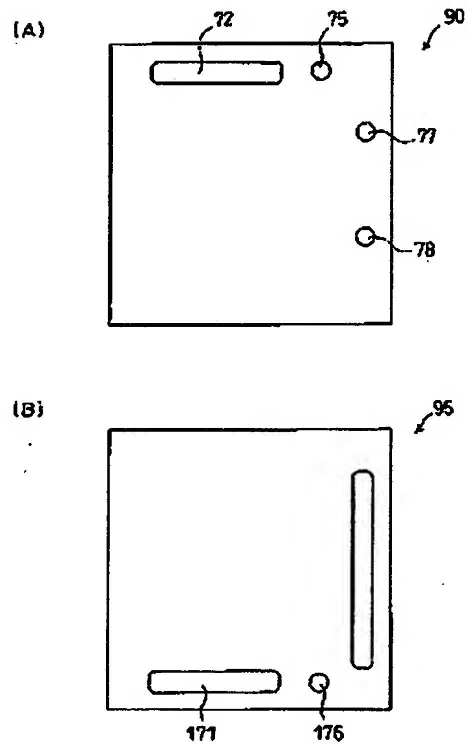
【図10】


(A)
S:2
S:1.5
S:1.25
電圧 (V)
0
時間t (s)
(B)
S:2
S:1.5
電圧 (V)
0
時間t (s)

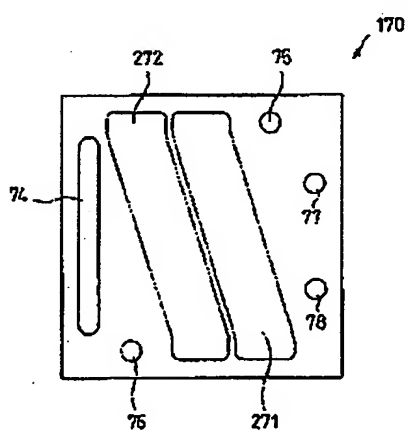
【図11】



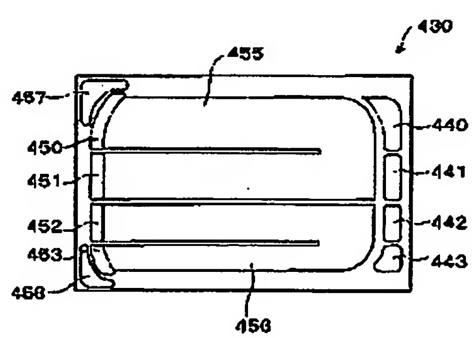
【図12】



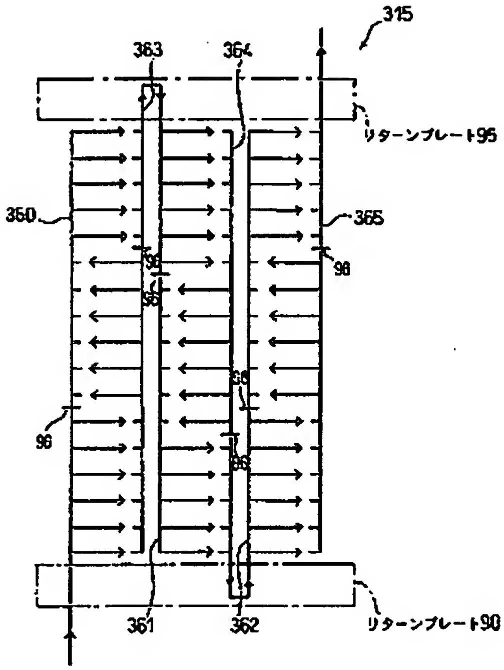
【図13】



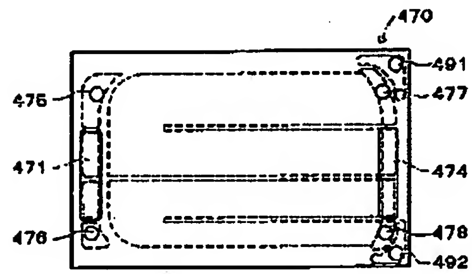
【図15】



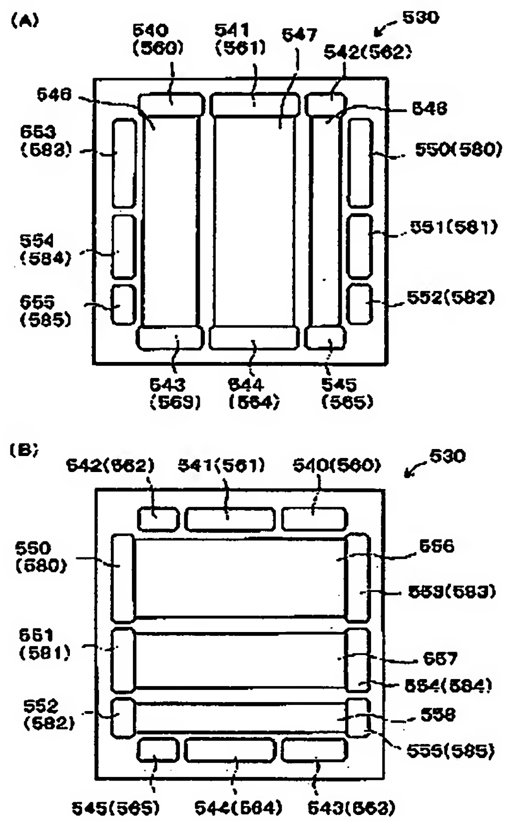
【図14】



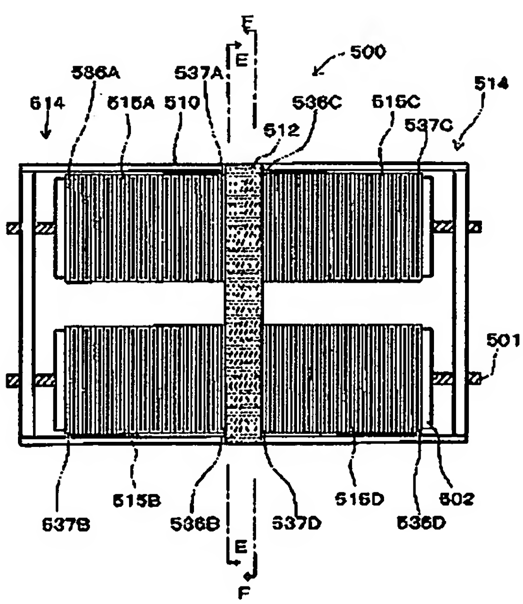
【図16】



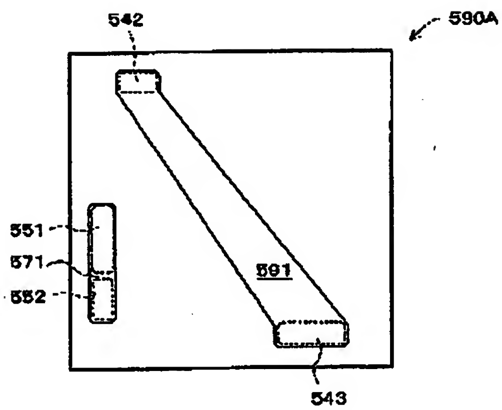
【図18】



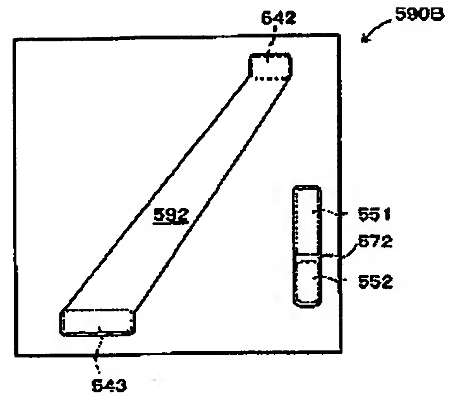
【図17】



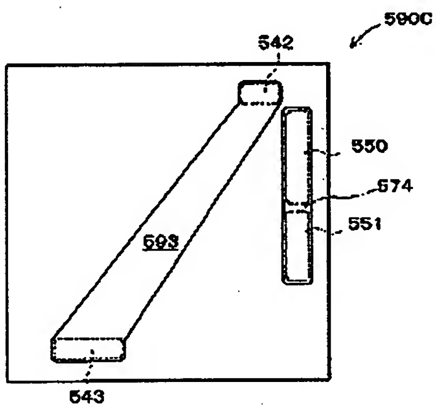
【図19】



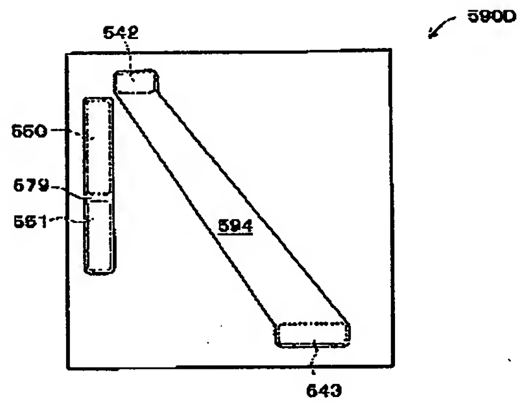
【図20】



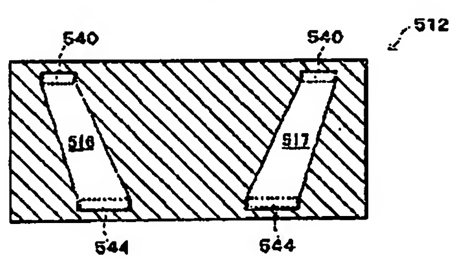
【図21】



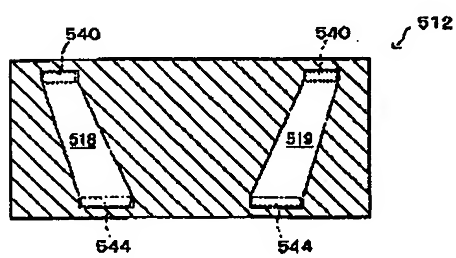
【図22】



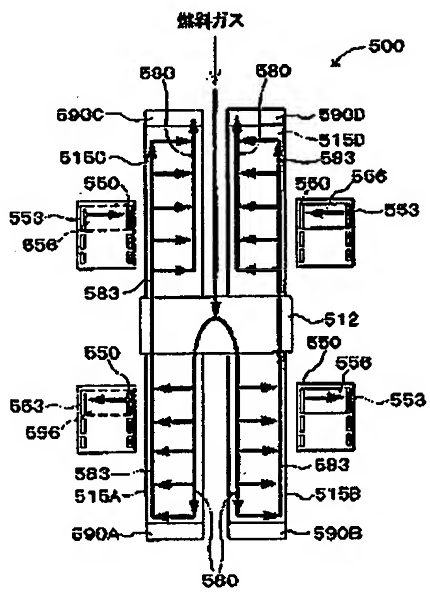
【図26】



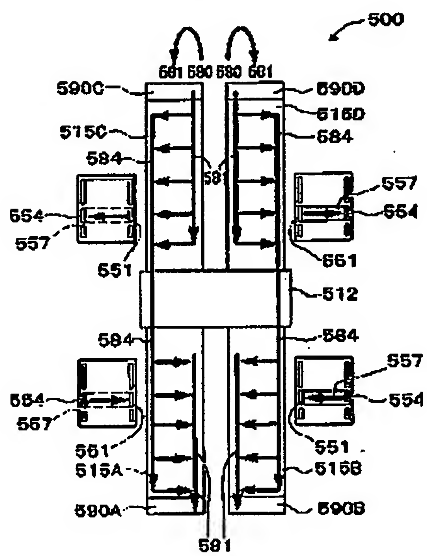
【図27】



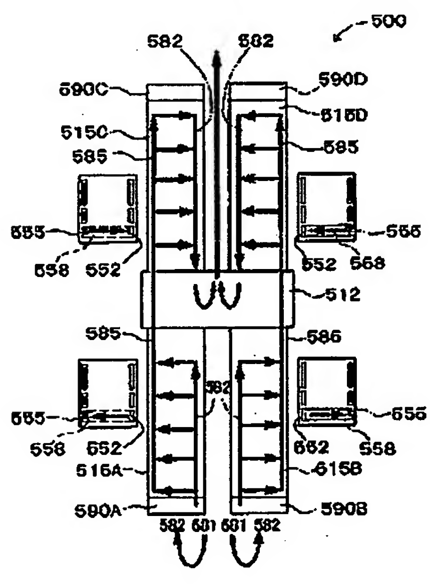
【図23】



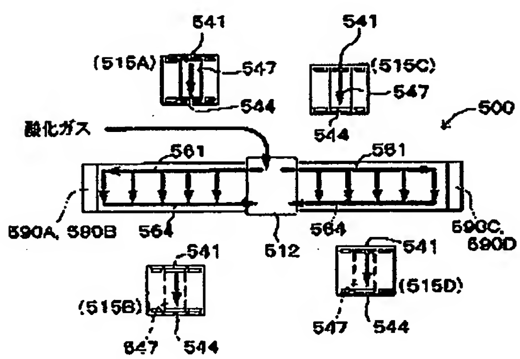
【図24】



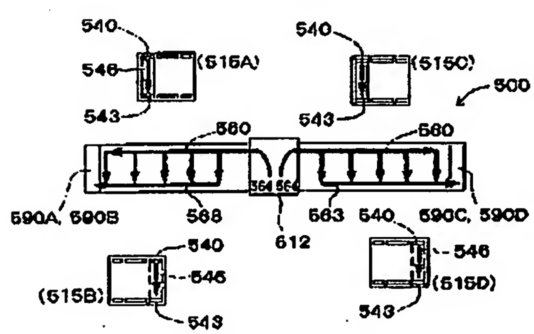
【図25】



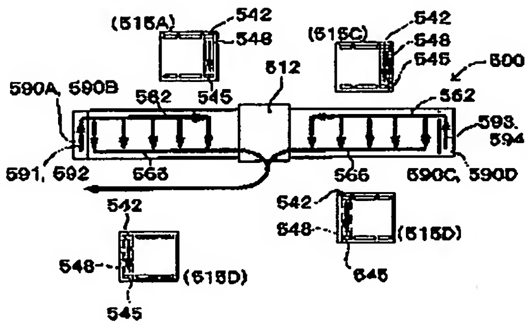
【図28】



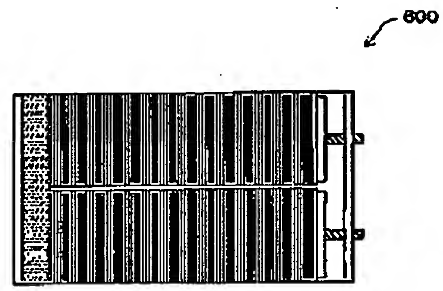
【図29】



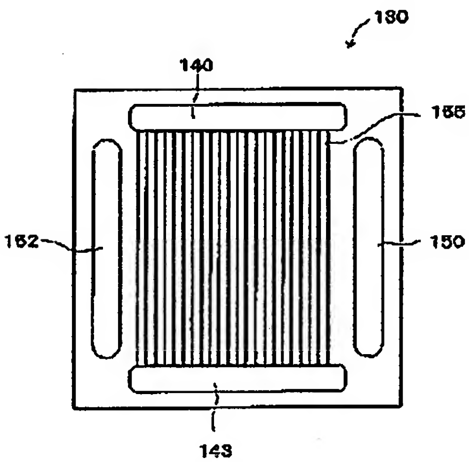
【図30】


(515A)
542
548
545
(515C)
542
548
545
500
512
590A, 590B
562
562
593,
594
591, 592
563
566
590C, 590D
542
548
(515D)
542
548
545
545

【図31】


600

【図32】


130
140
155
152
150
143

JP 2000-12051 A5 2004.7.29

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第７部門第１区分
【発行日】平成16年7月29日(2004.7.29)

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【ＦＩ】
　Ｈ０１Ｍ　8/02　　R
　Ｈ０１Ｍ　8/02　　B

【手続補正書】
【提出日】平成15年7月10日(2003.7.10)
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項１】
電解質層および電極を形成する部材と共に積層することによって燃料電池を構成可能となり、該燃料電池内部でガス流路を形成する燃料電池用ガスセパレータであって、
該燃料電池用ガスセパレータをその厚み方向に貫通する２つの孔構造と、該２つの孔構造を前記燃料電池用ガスセパレータの一方の面の上で連通させると共に前記一方の面の上方から見てＵ字型を成す凹部と、からなる単セル内流路形成部を、前記一方の面上にそれぞれ独立して互いに連通することなく複数備え、
　複数の前記単セル内流路形成部は、各々が備える前記凹部のＵ字型が同一の方向を向くと共に、各々が２つずつ備える前記孔構造が前記燃料電池用ガスセパレータの辺縁部に沿って配置されるように、互いに隣接して形成され、
　前記燃料電池用ガスセパレータを積層して燃料電池を構成する際には、前記単セル内流路形成部によって前記ガス流路を形成する
　燃料電池用ガスセパレータ。
【請求項２】
請求項１記載の燃料電池用ガスセパレータであって、
前記凹部は、該凹部の凹面から突出して設けられた複数の凸部を備える
燃料電池用ガスセパレータ。
【請求項３】
請求項１記載の燃料電池用ガスセパレータであって、
前記凹部は、平行に形成された複数のリブを備える
　燃料電池用ガスセパレータ。
【請求項４】
請求項１ないし３いずれか記載の燃料電池用ガスセパレータであって、
前記凹部は、Ｕ字型を形成する２つの直線領域のうち、前記ガス流路を形成したときに前記ガスの流れの下流側となる一方の直線領域の幅が、前記ガスの流れの上流側となる他方の直線領域の幅に比べて狭く形成されている
燃料電池用ガスセパレータ。
【請求項５】
請求項１ないし４いずれか記載の燃料電池用ガスセパレータであって、

前記複数の単セル内流路形成部を前記燃料電池用ガスセパレータの両面に備え、
前記燃料電池用ガスセパレータの２つの面のうち、第１の面上に形成される前記複数の単セル内流路形成部の各々が備える前記凹部と、第２の面上に形成される前記複数の単セル内流路形成部の各々が備える前記凹部とは、互いに逆向きのU字型をなし、
前記第１の面上に形成される前記複数の単セル内流路形成部の各々が２つずつ備える前記孔構造と、前記第２の面上に形成される前記複数の単セル内流路形成部の各々が２つずつ備える前記孔構造とは、それぞれ、前記燃料電池用ガスセパレータの互いに対向する辺縁部に沿って配置されている
燃料電池用ガスセパレータ。

【請求項６】
電解質層と電極およびガスセパレータを含む部材からなる単セルを複数積層してなるスタック構造を有し、電極活物質を含有するガスの供給を受けて、電気化学反応により起電力を得る燃料電池であって、
前記スタック構造は、内部を前記ガスが通過する流路として、複数の分割流路形成部を備え、
前記複数の分割流路形成部のそれぞれは、前記スタック構造の積層方向に形成される流路であって、内部を通過する前記ガスを各単セルに分配するガス供給マニホールドと、前記スタック構造の積層方向に形成される流路であって、各単セルから排出される前記ガスが集合するガス排出マニホールドと、前記スタック構造を構成する各単セル内に形成され、前記ガス供給マニホールドと前記ガス排出マニホールドとを連通させて、前記各単セルを構成する前記電解質層および前記電極の一部の領域に対して前記ガスを給排する単セル内ガス流路とからなり、
前記各単セルが備えるそれぞれの前記ガスセパレータにおける少なくとも一方の面上では、前記分割流路形成部が備える前記単セル内ガス流路を形成する凹部が、前記複数の分割流路形成部のそれぞれに対応して、互いに連通することなく複数設けられており、
前記スタック構造の端部において、前記複数の分割流路形成部のうちの一つが備える前記ガス排出マニホールドの端部と、前記複数の分割流路形成部のうちの他の一つが備える前記ガス供給マニホールドの端部とを接続する流路接続部を備え、
前記燃料電池に供給された前記ガスは、前記複数の分割流路形成部を、前記流路接続部を介しながら順次通過する
ことを特徴とする燃料電池。

【請求項７】
請求項６記載の燃料電池であって、
前記電極活物質を含有するガスは、酸素を含有する酸化ガスであり、
それぞれの前記単セルにおいて、前記酸化ガスが流入する前記単セル内ガス流路は、内部を通過する前記酸化ガスの流れの方向が、重力に従う場合と同様に上方から下方へ向かう方向となるように形成された
燃料電池。

【請求項８】
請求項６記載の燃料電池であって、
前記分割流路形成部が備える前記ガス供給マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路に対して、前記ガスを同時に供給し、
前記分割流路形成部が備える前記ガス排出マニホールドは、前記スタック構造に備えられたすべての前記単セル内に形成される前記単セル内ガス流路から同時に排出される前記ガスが集合する
ことを特徴とする燃料電池。

【請求項９】
請求項６記載の燃料電池であって、
前記スタック構造の積層方向に形成され、前記ガス供給マニホールドあるいは前記ガス排

出マニホールドとして働く複数の管状構造を備え、
前記管状構造の少なくとも一つは、内部の所定の位置に、内部を通過するガスの流れを遮断する遮断部を有し、
前記遮断部よりも前記ガスの流れの上流側に配設された前記単セルでは、前記遮断部を有する前記管状構造を前記ガス供給マニホールドとして働かせ、前記上流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスが同時に供給され、
前記遮断部よりも前記ガスの流れの下流側に配設された前記単セルでは、前記遮断部よりも上流側で前記ガス排出マニホールドとして働いた前記管状構造を前記ガス供給マニホールドとして働かせ、前記下流側に配設された前記単セルが備える前記単セル内ガス流路のそれぞれに対して前記ガスを同時に供給する
ことを特徴とする燃料電池。
【請求項１０】
請求項6記載の燃料電池であって、
該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、
前記燃料電池に供給される前記ガスは、予め分割された後に複数の前記スタック構造のそれぞれに対して供給されることを特徴とする
燃料電池。
【請求項１１】
請求項6記載の燃料電池であって、
該燃料電池は、複数の前記分割流路形成部を備える前記スタック構造を、複数備え、
複数の前記スタック構造の内の所定の一つに供給された前記ガスは、該所定のスタック構造が備える複数の前記分割流路形成部を順次通過する途中で、前記所定のスタック構造とは異なる前記スタック構造が備える前記分割流路形成部を経由することを特徴とする
燃料電池。
【請求項１２】
請求項6記載の燃料電池であって、
前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が同一の方向を向き、かつ、互いに隣接するように配置されており、
それぞれの前記凹部が形成する前記単セル内ガス流路は、Ｕ字形をなす前記凹部の両端部において、前記ガス供給マニホールドおよび前記ガス排出マニホールドと接続し、
前記複数の分割流路形成部のそれぞれが備える前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の側面の一つに沿って互いに隣接して配設されることを特徴とする
燃料電池。
【請求項１３】
請求項6記載の燃料電池であって、
前記ガスセパレータは、前記複数の凹部を、その両面にそれぞれ有し、
前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が第１の方向を向き、かつ、互いに隣接するように配置されており、
前記ガスセパレータの他方の面上に形成される複数の前記凹部は、前記他方の面の上方から見て、それぞれ、Ｕ字形をなし、各々のＵ字形が前記第１の方向とは逆向きの第２の方向を向き、かつ、互いに隣接するように配置されており、
前記ガスセパレータの一方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第１の側面に沿って、互いに隣接するように配設され、
前記ガスセパレータの他方の面上に形成された複数の前記凹部が形成する前記単セル内ガス流路のいずれかと連通する前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の第１の側面と対向する第２の側面に沿って、互いに隣接するよう

に配設されていることを特徴とする
燃料電池。
【請求項１４】
請求項１２記載の燃料電池であって、
燃料電池内部との間で熱交換することによって、前記電気化学反応に伴って生じる熱を取り除いて、燃料電池内部の温度が非所望の温度に上昇してしまうのを防ぐ冷却液を、その内部に通過させる流路であって、燃料電池内部の所定の複数の位置に設けられた冷却液路と、
前記スタック構造の積層方向に形成され、前記冷却液を前記冷却液路に分配する、あるいは、前記各冷却液路を通過した前記冷却液が集合する冷却液マニホールドとを備え、
前記冷却液マニホールドは、前記スタック構造を形成する側面の一つに沿って互いに隣接して設けられた前記ガス供給マニホールドおよび前記ガス排出マニホールドの近傍に設けられ、前記ガス供給マニホールドおよび前記ガス排出マニホールドが配設された位置よりも、前記単セル内ガス流路が形成される場所から離れた位置に設けられたことを特徴とする
燃料電池。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】００１２
【補正方法】変更
【補正の内容】
【００１２】
【課題を解決するための手段およびその作用・効果】
本発明の燃料電池用ガスセパレータは、電解質層および電極を形成する部材と共に積層することによって燃料電池を構成可能となり、該燃料電池内部でガス流路を形成する燃料電池用ガスセパレータであって、
該燃料電池用ガスセパレータをその厚み方向に貫通する２つの孔構造と、該２つの孔構造を前記燃料電池用ガスセパレータの一方の面の上で連通させると共に前記一方の面の上方から見てＵ字型を成す凹部と、からなる単セル内流路形成部を、前記一方の面上にそれぞれ独立して互いに連通することなく複数備え、
　複数の前記単セル内流路形成部は、各々が備える前記凹部のＵ字型が同一の方向を向くと共に、各々が２つずつ備える前記孔構造が前記燃料電池用ガスセパレータの辺縁部に沿って配置されるように、互いに隣接して形成され、
　前記燃料電池用ガスセパレータを積層して燃料電池を構成する際には、前記単セル内流路形成部によって前記ガス流路を形成することを要旨とする。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００２１
【補正方法】変更
【補正の内容】
【００２１】
また、特に本発明の燃料電池用ガスセパレータを用いて燃料電池を構成すると、同種のガスが通過するガス供給マニホールドおよびガス排出マニホールドが、スタック構造の側面に一つに沿って配設されることになり、同種のガスが通過するガスマニホールド間ではガスのシール性を厳密に確保する必要がないため、ガスマニホールドを形成する領域のシール構造を簡素化することができる。また、単セル内ガス流路を形成する凹部の形状をＵ字形にすることにより、凹部を直線状に形成してその両端部にガスマニホールドのための孔部を形成する場合に比べて、ガスセパレータ表面のより広い領域を単セル内ガス流路に利用することが可能となり、ガスセパレータおよびこれを用いる燃料電池を小型化することができる。

JP,2000-012051,A STANDARD ZOOM-UP ROTATION No Rotation REVERSAL RELOAD
PREVIOUS PAGE NEXT PAGE DETAIL

このような本発明の燃料電池用ガスセパレータにおいて、前記凹部は、該凹部の凹面から突出して設けられた複数の凸部を備えることとしても良い。このような凸部を設けることで、凹部によって形成される単セル内ガス流路を通過するガスを攪拌することができる。

あるいは、本発明の燃料電池用ガスセパレータにおいて、前記凹部は、平行に形成された複数のリブを備えることとしても良い。このような場合には、上記複数のリブを設けることでガス流路が形成される。

また、本発明の燃料電池用ガスセパレータにおいて、前記凹部は、U字型を形成する2つの直線領域のうち、前記ガス流路を形成したときに前記ガスの流れの下流側となる一方の直線領域の幅が、前記ガスの流れの上流側となる他方の直線領域の幅に比べて狭く形成されていることとしても良い。このような構成とすれば、下流側の流路断面積が小さくなるため、下流側ほどガス流量が減少してしまうのを補い、電圧を確保することができる。

【手続補正4】
【補正対象書類名】明細書
【補正対象項目名】００２４
【補正方法】削除
【補正の内容】

【手続補正5】
【補正対象書類名】明細書
【補正対象項目名】００２５
【補正方法】変更
【補正の内容】
【００２５】
また、本発明の燃料電池において、
前記ガスセパレータの一方の面上に形成される複数の前記凹部は、前記一方の面の上方から見て、それぞれ、U字形をなし、各々のU字形が同一の方向を向き、かつ、互いに隣接するように配置されており、
それぞれの前記凹部が形成する前記単セル内ガス流路は、U字形をなす前記凹部の両端部において、前記ガス供給マニホールドおよび前記ガス排出マニホールドと接続し、
前記複数の分割流路形成部のそれぞれが備える前記ガス供給マニホールドおよび前記ガス排出マニホールドは、前記スタック構造の側面の一つに沿って互いに隣接して配設されることとしてもよい。

【手続補正6】
【補正対象書類名】明細書
【補正対象項目名】００２６
【補正方法】変更
【補正の内容】
【００２６】
このような本発明の燃料電池によれば、同種のガスが通過するガス供給マニホールドおよびガス排出マニホールドが、スタック構造の側面に一つに沿って配設されており、同種のガスが通過するガスマニホールド間ではガスのシール性を厳密に確保する必要がないため、ガスマニホールドを形成する領域のシール構造を簡素化することができる。また、単セル内ガス流路を形成する凹部の形状をU字形にすることにより、凹部を直線状に形成してその両端部にガスマニホールドのための孔部を形成する場合に比べて、ガスセパレータ表面のより広い領域を単セル内ガス流路に利用することが可能となり、ガスセパレータおよびこれを用いる燃料電池を小型化することができる。

【手続補正7】
【補正対象書類名】明細書
【補正対象項目名】００２９
【補正方法】変更

【補正の内容】
【0029】
また、本発明の燃料電池用ガスセパレータは、
前記複数の単セル内流路形成部を前記燃料電池用ガスセパレータの両面に備え、
前記燃料電池用ガスセパレータの2つの面のうち、第1の面上に形成される前記複数の単セル内流路形成部の各々が備える前記凹部と、第2の面上に形成される前記複数の単セル内流路形成部の各々が備える前記凹部とは、互いに逆向きのU字型をなし、
前記第1の面上に形成される前記複数の単セル内流路形成部の各々が2つずつ備える前記孔構造と、前記第2の面上に形成される前記複数の単セル内流路形成部の各々が2つずつ備える前記孔構造とは、それぞれ、前記燃料電池用ガスセパレータの互いに対向する辺縁部に沿って配置されていることとしても良い。

CLAIMS

[Claim(s)]
[Claim 1]A gas separator for fuel cells which composition of a fuel cell of is attained and forms a gas passageway inside this fuel cell by laminating with a member which forms an electrolyte layer and an electrode characterized by comprising the following.
two holes which penetrate this gas separator for fuel cells to the thickness direction -- structure.
this 2 ** hole -- a crevice which makes structure open for free passage on one field of said gas separator for fuel cells.

[Claim 2]The gas separator for fuel cells according to claim 1 which has a flow path forming part in a single cell of said plurality to the both sides.
[Claim 3]Said two or more crevices which are the gas separators for fuel cells according to claim 1, and are formed on one field of this gas separator for fuel cells, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And a gas separator for fuel cells, wherein it is arranged so that it may adjoin mutually, and the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell, respectively is arranged along a peripheral area of said gas separator for fuel cells so that it may adjoin mutually.
[Claim 4]Are the gas separator for fuel cells according to claim 1, and both sides of said gas separator for fuel cells are equipped with a flow path forming part in a single cell of said plurality, Said two or more crevices formed on one field of said gas separator for fuel cells, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator for fuel cells, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell which are arranged so that it may adjoin mutually, and are formed on one field of said gas separator for fuel cells, respectively, Along the 1st peripheral area of said gas separator for fuel cells, it is arranged so that it may adjoin mutually, The aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell formed on a field of another side of said gas separator for fuel cells, respectively meets said 1st peripheral area of said gas separator for fuel cells, and the 2nd peripheral area that counters, A gas separator for fuel cells arranging so that it may adjoin mutually.
[Claim 5]It has the stack structure which carries out the plural laminates of the single cell which consists of a member containing an electrolyte layer, an electrode, and a gas separator, In response to supply of gas containing an electrode active material, are a fuel cell which acquires electromotive force according to electrochemical reaction, and said stack structure, As a channel where said gas passes an inside, have two or more divided-flow way formation parts, and each of two or more of said divided-flow way formation parts, A gas supply manifold which distributes said gas which is a channel formed in a laminating direction of said stack structure, and passes an inside to each single cell, A gas exhaust

manifold in which it is a channel formed in a laminating direction of said stack structure, and said gas discharged from each single cell gathers, It is formed in each single cell which constitutes said stack structure, and said gas supply manifold and said gas exhaust manifold are made to open for free passage, It consists of a gas passageway in a single cell which carries out the feeding and discarding of said gas to said electrolyte layer which constitutes said each single cell, and some fields of said electrode, A crevice which forms a gas passageway in said single cell with which said divided-flow way formation part is provided on at least one [in said each gas separator with which said each single cell is provided] field corresponds to each of two or more of said divided-flow way formation parts, In [more than one are provided without being mutually open for free passage and] an end of said stack structure, An end of said gas exhaust manifold with which one of said two or more divided-flow way formation parts is provided, A fuel cell, wherein said gas which was provided with a channel terminal area which connects an end of said gas supply manifold with which one of the others of said two or more divided-flow way formation parts is provided, and was supplied to said fuel cell passes said two or more divided-flow way formation parts one by one via said channel terminal area.

[Claim 6]Gas which is the fuel cell according to claim 5, and contains said electrode active material, A fuel cell which is the oxidizing gas containing oxygen, and was formed in said each single cell so that a gas passageway in said single cell into which said oxidizing gas flows might serve as a direction which goes to a lower part from the upper part like a case where a flow direction of said oxidizing gas which passes an inside follows gravity.

[Claim 7]Said gas supply manifold which is the fuel cell according to claim 5 and with which said divided-flow way formation part is provided, As opposed to a gas passageway in said single cell formed in said all single cells with which said stack structure was equipped, A fuel cell with which said gas simultaneously discharged from a gas passageway in said single cell formed in said all single cells by which said stack structure was equipped with said gas exhaust manifold which supplies said gas simultaneously, and with which said divided-flow way formation part is provided is characterized by gathering.

[Claim 8]Are the fuel cell according to claim 5, and it is formed in a laminating direction of said stack structure, Have two or more tubular structure committed as said gas supply manifold or said gas exhaust manifold, and at least one of said the tubular structure. In said single cell which has a blocking section which intercepts a flow of gas which passes an inside in an internal position, and was allocated in it by the upstream of a flow of said gas rather than said blocking section. Said tubular structure which has said blocking section is used as said gas supply manifold, Said gas is simultaneously supplied to each of a gas passageway in said single cell with which said single cell allocated in said upstream is provided, In said single cell allocated in the downstream of a flow of said gas rather than said blocking section. A fuel cell supplying said gas simultaneously to each of a gas passageway in said single cell with which said single cell which used said tubular structure committed as said gas exhaust manifold by the upstream as said gas supply manifold, and was allocated in said downstream rather than said blocking section is provided.

[Claim 9]A fuel cell which is the fuel cell according to claim 5, and is characterized by supplying it to each of two or more of said stack structures after said gas to which said stack structure which this fuel cell equips with said two or more divided-flow way formation parts is supplied by two or more preparations and said fuel cell is divided beforehand.

[Claim 10]Are the fuel cell according to claim 5, and this fuel cell, Said gas to which said stack structure provided with said two or more divided-flow way formation parts was supplied by one of predetermined [the / of two or more preparations and said two or more stack structures], A fuel cell going via said divided-flow way formation part with which said different stack structure from said predetermined stack structure is provided while passing said two or more divided-flow way formation parts with which stack structure predetermined [this] is provided one by one.

[Claim 11]Said two or more crevices which are the fuel cells according to claim 5, and are formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And a gas passageway in said single cell which it is

arranged so that it may adjoin mutually, and said crevice of ******** forms, It connects with said gas supply manifold and said gas exhaust manifold in both ends of said crevice which makes U type, A fuel cell, wherein said gas supply manifold with which each of two or more of said divided-flow way formation parts is provided, and said gas exhaust manifold adjoin mutually and are allocated along with one of the sides of said stack structure.
[Claim 12]Are the fuel cell according to claim 5, and said gas separator, Said two or more crevices which have said two or more crevices to the both sides, respectively, and are formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And either of the gas passagewaies in said single cell which said two or more crevices which are arranged so that it may adjoin mutually, and were formed on one field of said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold, Along the 1st side of said stack structure, it is allocated so that it may adjoin mutually, Either of the gas passagewaies in said single cell which said two or more crevices formed on a field of another side of said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold meet the 1st side of said stack structure, and the 2nd side that counters, A fuel cell currently allocating so that it may adjoin mutually.
[Claim 13]Have the following and said cooling fluid manifold is formed near said gas supply manifold which adjoined mutually and was provided along with one of the sides which form said stack structure, and said gas exhaust manifold, A fuel cell providing in a position which is distant from a place in which a gas passageway in said single cell is formed rather than a position in which said gas supply manifold and said gas exhaust manifold were allocated.
By being the fuel cell according to claim 11, and carrying out heat exchange between insides of a fuel cell, A cooling fluid way where heat produced in connection with said electrochemical reaction was removed, and temperature inside a fuel cell is a channel which makes the inside pass cooling fluid which prevents going up to a non-wanting temperature, and was provided in two or more predetermined positions inside a fuel cell.
A cooling fluid manifold which is formed in a laminating direction of said stack structure, and distributes said cooling fluid to said cooling fluid way or with which said cooling fluid which passed through said each cooling fluid way gathers.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention the gas separator for fuel cells, and this gas separator for fuel cells about the used fuel cell in detail, In the fuel cell which carries out the plural laminates of the single cell, and constitutes it, it is provided between the adjoining single cells, and a fuel gas flow route and an oxidizing gas passage are formed between the adjoining members, and it is related with the fuel cell using the separator for fuel cells which separates fuel gas and oxidizing gas, and this separator.
[0002]
[Description of the Prior Art]The gas separator for fuel cells is a member which constitutes the fuel cell stack by which two or more single cells were laminated, and has prevented mixing the fuel gas and oxidizing gas which are supplied to each of an adjacent single cell by having sufficient gas impermeability. Such a separator for fuel cells usually has rugged structure, such as the shape of a rib, on the surface.
It also has the work which forms the channel of fuel gas and oxidizing gas (the gas separator of such composition is also called interconnector with a rib).
That is, the separator for fuel cells forms the channel (channel in a single cell) of fuel gas or oxidizing gas between the adjoining member (gas diffusion layer) and the above-mentioned rugged structure, when included in a fuel cell stack.
[0003]The gas separator for fuel cells has a predetermined hole structure other than the rugged structure which forms the above-mentioned gas passageway. this hole -- the corresponding hole with which the adjacent gas separator was equipped when structure laminated a single cell provided with a gas separator and a fuel cell stack was constituted -- structures lap and the gas manifold which pierces through the inside of a fuel cell stack to that laminating direction is constituted. It is distributed to each single cell, such a gas manifold making an inside pass the fuel gas or oxidizing gas supplied from the outside of a fuel cell, or a fuel exhaust gas or oxidation exhaust gas after electrochemical reaction was presented by each single cell is introduced, and it leads these to the fuel cell exterior. Therefore, these gas manifolds are open for free passage with the above-mentioned channel in a single cell formed in each laminated single cell.
Gas is flowed out between a gas manifold and the channel in a single cell, and ON is possible.

[0004]Drawing 32 is an explanatory view which expresses the composition of the separator 130 superficially as an example of a gas separator known conventionally. the separator 130 -- the circumference near [the] -- four holes -- it has the vent 140,143 and the fuel hole 150,152 as a structure. When these vents and fuel holes laminate the member containing the separator 130 and constitute a fuel cell, they are an inside of a fuel cell and form an oxidizing gas supply manifold, an oxidizing gas exhaust manifold, a fuel gas supply manifold, and a fuel gas exhaust manifold, respectively.
[0005]The rib part 155 which connects the vent 140 and the vent 143 is formed in one field of the separator 130.

The rib part (not shown) which connects the fuel hole 150 and the fuel hole 152 is provided in the field of another side of the separator 130.
Here, these rib parts were taken as the grooved structure formed in parallel. When the member containing the separator 130 is laminated and a fuel cell is constituted, these rib parts form the gas passageway in a single cell between the members which adjoin the separator 130. That is, the rib part 155 which connects the vent 140 and the vent 143 forms the oxidizing gas passage in a single cell, and the rib part which connects the fuel hole 150 and the fuel hole 152 forms the fuel gas flow route in a single cell. The oxidizing gas supplied to the fuel cell passes through the inside of the oxidizing gas supply manifold formed of the vent 140, is distributed to the oxidizing gas passage in a single cell formed in each single cell, after electrochemical reaction is presented with it, it joins by an oxidizing gas exhaust manifold, and it is discharged by the fuel cell exterior. Similarly, the fuel gas supplied to the fuel cell passes through the inside of the fuel gas supply manifold formed of the fuel hole 150, is distributed to the fuel gas flow route in a single cell formed in each single cell, after electrochemical reaction is presented with it, it joins by a fuel gas exhaust manifold, and it is discharged by the fuel cell exterior.
[0006]In the fuel cell which presents electrochemical reaction with such fuel gas and oxidizing gas, and acquires electromotive force, to raise the capacity factor of the gas supplied is desired. Namely, although the gas (fuel gas or oxidizing gas) containing an electrode active material (hydrogen or oxygen) is supplied to a fuel cell, Since all the electrode active materials in gas may be used by electrochemical reaction, in order to fully advance electrochemical reaction, the gas containing the electrode active material of the quantity exceeding the quantity needed theoretically is supplied to the fuel cell. Therefore, the electrode active material in gas is carried out that it is easy to be used by electrochemical reaction, the capacity factor of gas is raised, and to stop the gas volume supplied to a fuel cell is desired. If the gas volume supplied to a fuel cell is stopped, the amount of consumption of hydrogen can be stopped in fuel gas. In oxidizing gas, the amount of energy consumed in order to pressurize oxidizing gas (usually air) can be stopped, and the energy efficiency of the whole system provided with a fuel cell can be raised.
[0007]In order to carry out the electrode active material in gas that it is easy to be used by electrochemical reaction and to raise the capacity factor of gas, gas is well stirred in a channel and should just change into the state where it is spread. It can be made easy to contact by this in the catalyst and electrode active material with which the electrode was equipped. The method of gas being well stirred in a channel, increasing the flow of the gas which passes through the inside of this channel, for example in the channel in a single cell, in order to change into the state where it is spread, and making the rate of flow quick can be chosen. Although how to make small the passage cross section of the channel in a single cell can be considered as a method of increasing the flow of the gas which passes through the inside of a channel, The composition which makes shape of the above-mentioned rugged structure which is formed on a gas separator and forms the channel in a single cell as such composition picture-drawn-without-lifting-the-brush-from-the-paper structure is proposed (for example, JP,7-263003,A etc.). Here, the gas supplied to each single cell is introduced in the thin channel continued and formed on the same side. Therefore, even if the gas volume supplied to a fuel cell from the exterior is the same, Compared with the case where it has composition which makes the wider range on the same field pass gas simultaneously in each single cell like composition of having been shown in drawing 32, the rate of flow of the gas which passes through the arbitrary places of a channel can be made quick, and the capacity factor of gas can be raised.
[0008]
[Problem(s) to be Solved by the Invention]However, when making rugged structure formed on the gas separator into picture-drawn-without-lifting-the-brush-from-the-paper structure which was described above, since the channel in a single cell is finely bent on the same field, the pressure loss produced when gas passes through such a channel in a single cell will become large. Therefore, in order to maintain the flow of the gas which passes through the inside of a channel to the specified quantity. It is necessary to enlarge the grade which pressurizes the gas supplied to a fuel cell, the energy consumed in order to

pressurize gas by this increases, and the inconvenience that the energy efficiency of the whole system provided with a fuel cell will fall is produced.
[0009]The composition which divides into two or more fields the gas passageway formed on a separator apart from the above-mentioned gazette is also proposed (for example, JP,58-138268,U etc.). In such a fuel cell, the gas passageway divided into two or more fields is formed on the gas separator (bipolar plate). The gas supplied in the single cell from the gas supply hole passes through two or more above-mentioned fields one by one, and reaches gas exhaust. Although the rate of flow of the gas which passes through the inside of a channel also as such composition can be made quick and the rate of gas utilization can be raised, The flow of gas as well as the structure of the above-mentioned picture drawn without lifting the brush from the paper is continuing within a single cell, and further, since gas set holes are connected according to a diaphragm, the problem of the above-mentioned pressure loss cannot fully be solved. Since the flow of gas is continuing within a single cell, the composition shown in JP,7-263003,A and the composition shown in JP,58-138268,U have a possibility that distribution of the gas to each single cell may not be performed uniformly enough.
[0010]As described above, to make small the passage cross section of the channel in a single cell, it is necessary to form more finely the rugged structure formed on a gas separator but, and by this, when manufacturing a gas separator, the accuracy more than before will be required. However, when accuracy becomes insufficient with difficulty, raising the accuracy at the time of forming rugged structure in the surface at the time of manufacture of a gas separator. There is a possibility that inconvenience, such as dispersion in the battery capacity resulting from the fall (increase in inferior goods) of the yield at the time of manufacture and the fall of the accuracy at the time of forming rugged structure, may arise.
[0011]The fuel cell using the gas separator for fuel cells of this invention, and this gas separator for fuel cells, Such a problem was solved, it was made for the purpose of raising the capacity factor of the gas supplied to a fuel cell, without reducing the energy efficiency of the whole system provided with a fuel cell, and the next composition was taken.
[0012]
[The means for solving a technical problem, and its operation and effect] Composition of a fuel cell of the gas separator for fuel cells of this invention is attained by laminating with the member which forms an electrolyte layer and an electrode, two holes which are the gas separators for fuel cells which form a gas passageway inside this fuel cell, and penetrate this gas separator for fuel cells to the thickness direction -- with structure. this 2 ** hole -- the flow path forming part in a single cell which consists of a crevice which makes structure open for free passage on one field of said gas separator for fuel cells, When you form more than one in said field side of said gas separator for fuel cells, you laminate said gas separator for fuel cells and you constitute a fuel cell, without being mutually open for free passage independently, respectively, let it be a gist to form said gas passageway by the flow path forming part in said single cell.
[0013]A gas separator for fuel cells of this invention constituted as mentioned above, two holes which constitute each flow path forming part in a single cell when this gas separator is laminated and a fuel cell is constituted -- a gas passageway (gas manifold) which passes gas is formed in a laminating direction of a gas separator by structure. one field top of said gas separator -- said two holes -- a gas passageway (gas passageway in a single cell) which supplies gas to said electrolyte layer and said electrode by said crevice which makes structure open for free passage is formed. setting to said field side of said gas separator here -- said two holes -- a gas-passageway formation part in a single cell which consists of structure and said crevice, Since more than one are formed without being mutually open for free passage independently, respectively, when gas supplied to a fuel cell is distributed to a gas passageway formed in said gas separator surface, Gas is not supplied from a single gas manifold at once to the whole surface on the predetermined surface of a gas separator. When gas supplied to a fuel cell is distributed, gas is supplied from a respectively separate gas manifold for every gas passageway in a single cell of each which a flow path forming part in a single cell which divided the surface of a gas separator and was provided forms.
[0014]A fuel cell of this invention has the stack structure which carries out the plural laminates of the

single cell which consists of a member containing an electrolyte layer, an electrode, and a gas separator, In response to supply of gas containing an electrode active material, are a fuel cell which acquires electromotive force according to electrochemical reaction, and said stack structure, As a channel where said gas passes an inside, have two or more divided-flow way formation parts, and each of two or more of said divided-flow way formation parts, A gas supply manifold which distributes said gas which is formed in a laminating direction of said stack structure, and passes an inside to each single cell, A gas exhaust manifold in which said gas which is formed in a laminating direction of said stack structure, and is discharged from each single cell gathers, It is formed in each single cell which constitutes said stack structure, and said gas supply manifold and said gas exhaust manifold are made to open for free passage, It consists of a gas passageway in a single cell which carries out the feeding and discarding of said gas to said electrolyte layer which constitutes said each single cell, and some fields of said electrode, Two or more crevices which form a gas passageway in said single cell with which said divided-flow way formation part is provided on at least one [in said each gas separator with which said each single cell is provided] field are provided corresponding to each of two or more of said divided-flow way formation parts, without being mutually open for free passage. An end of said gas exhaust manifold with which one of said two or more divided-flow way formation parts is provided in an end of said stack structure, Said gas which was provided with a channel terminal area which connects an end of said gas supply manifold with which one of the others of said two or more divided-flow way formation parts is provided, and was supplied to said fuel cell makes it a gist to pass said two or more divided-flow way formation parts one by one via said channel terminal area.
[0015]Stack structure with which a fuel cell of this invention constituted as mentioned above is provided is provided with inside of two or more divided-flow way formation parts. Each divided-flow way formation part is formed from a gas passageway in a single cell which was open for free passage with two gas manifolds and these two gas manifolds, and was provided in each single cell, respectively, Within said divided-flow way formation part, said gas passing an inside of one gas manifold to a laminating direction of said stack structure. It is distributed to a gas passageway in said each single cell which is open for free passage to this one gas manifold, and electrochemical reaction in each single cell is presented, From said each gas passageway in a single cell, it is further discharged by gas manifold of another side, and passes through inside of a gas manifold of this another side to a laminating direction of said stack structure. As for gas which two or more divided-flow way formation parts were connected one by one by said channel terminal area in said gas manifold end with which each divided-flow way formation part is provided, and was supplied from the outside, said divided-flow way formation part is passed one by one.
[0016]Here, on at least one [in said gas separator with which each single cell is provided] field, a crevice which forms a gas passageway in said single cell is provided, and this crevice is provided corresponding to each of two or more of said divided-flow way formation parts. Since a crevice of these plurality is formed without being mutually open for free passage on one field of a gas separator, When gas supplied to a fuel cell is distributed to a gas passageway formed in an inside of a single cell, gas is not supplied from a single gas manifold at once to the whole surface on the predetermined surface of a gas separator. When gas supplied to a fuel cell is distributed, gas is supplied from a respectively separate gas manifold for every gas passageway in a single cell of each which said crevice which divided the surface of a gas separator and was provided forms.
[0017]Therefore, according to a fuel cell constituted using a gas separator for fuel cells of this invention, and the fuel cell of this invention. To the whole gas passageway in a single cell provided in the gas separator surface, when gas is supplied at once from a single gas manifold, it compares, Since a flow of gas passed per unit sectional area of a gas passageway in a single cell increases and the rate of flow speeds up, the diffusibility of gas in a channel improves and an electrode active material in gas reaches easily a catalyst established on an electrode. Therefore, since an electrode active material becomes is easy to be used by electrochemical reaction and a capacity factor of gas improves, an effect that gas volume which should be supplied to a fuel cell can be stopped is done so.
[0018]When the rate of flow of gas in a gas passageway in a single cell speeds up, in a channel of

oxidizing gas containing especially oxygen, an effect that wastewater nature in a channel can be raised is done so. When electrochemical reaction advances in a fuel cell, in the cathode side with which oxidizing gas is supplied, produced water arises, this produced water is evaporated in oxidizing gas, and it is discharged out of a fuel cell, but when produced water stagnates without the ability to evaporate in oxidizing gas, there is a possibility of coming to bar diffusion of gas. By speeding up the rate of flow of oxidizing gas in a gas passageway in a single cell, it can prevent urging that produced water evaporates in oxidizing gas, and produced water stagnating, and barring diffusion of gas.

[0019]Since a total amount of gas which should be supplied to a fuel cell can be reduced, an effect that a humidifying amount to oxidizing gas supplied to a fuel cell can be reduced is also acquired. In a polymer electrolyte fuel cell, since a part of moisture which electrolyte membranes including produced water which is produced in the cathode side, and which was mentioned already hold is evaporated in oxidizing gas and it is discharged out of a fuel cell, it usually humidified beforehand oxidizing gas supplied to a fuel cell, and has prevented desiccation of an electrolyte membrane. If a total amount of oxidizing gas supplied to a fuel cell can be reduced as described above, a moisture content carried out out of a fuel cell by oxidizing gas can be lessened more, and a humidifying amount of oxidizing gas supplied to a fuel cell can be reduced. An amount of energy consumed by this in order to humidify oxidizing gas is reducible. When using reformed gas which obtained it by carrying out steam reforming of the hydrocarbon as fuel gas supplied to a fuel cell, special composition which humidifies fuel gas is unnecessary, but to use hydrogen gas as fuel gas, before supplying a fuel cell, it is necessary to humidify. Also in this case, since a total amount of gas which should be supplied to a fuel cell can be reduced, a humidifying amount can be stopped and an effect that an amount of energy consumed for humidification is reducible can be acquired.

[0020]According to a fuel cell constituted using a gas separator for fuel cells of this invention, and the fuel cell of this invention. Since gas is supplied from a gas manifold which a field to which oxidizing gas or fuel gas is supplied is divided in arbitrary single cells, and is different to each field, Also when the water of condensation stagnates in a terminal area of a gas manifold and a channel in a single cell, there is no possibility that supply of gas to a single cell may be severed thoroughly. Namely, even if the water of condensation stagnates in the above-mentioned terminal area and supply of gas to a predetermined channel in a single cell is intercepted, A possibility that all the terminal areas corresponding to two or more gas passagewaies in a single cell formed on the same side of a gas separator will be blockaded simultaneously is very low, and it can prevent supply of gas to either of the single cells which constitute stack structure originating in stagnation of the water of condensation, and stopping.

[0021]In a gas separator for fuel cells of this invention, it is good also as having a flow path forming part in a single cell of said plurality to the both sides. If it has such composition, as described above, in a fuel cell constituted using a gas separator for fuel cells of this invention, an effect of raising a capacity factor of gas can be acquired in both a channel of fuel gas containing hydrogen, and a channel of oxidizing gas containing oxygen.

[0022]Gas which contains said electrode active material in a fuel cell of this invention, It is the oxidizing gas containing oxygen and a gas passageway in said single cell into which said oxidizing gas flows is good in said each single cell also as having been formed so that a flow direction of said oxidizing gas which passes an inside might turn into a direction which goes to a lower part from the upper part like a case where gravity is followed.

[0023]If it has such composition, in a gas passageway in a single cell which oxidizing gas passes, wastewater nature can be raised further. Namely, produced water produced in the cathode side with advance of electrochemical reaction in a fuel cell, Also when it has condensed by a gas passageway in a single cell, by making a flow direction of oxidizing gas in a gas passageway in a single cell go to a lower part from the upper part, the water of condensation becomes that it is easy to be discharged according to gravity, and can prevent it from the water of condensation stagnating in a channel and barring circulation of gas.

[0024]Said two or more crevices formed on one field of this gas separator for fuel cells in a gas

separator for fuel cells of this invention, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And it is arranged so that it may adjoin mutually, and the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell, respectively is good also as being arranged along a peripheral area of said gas separator for fuel cells, so that it may adjoin mutually.

[0025]Similarly in a fuel cell of this invention, said two or more crevices formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And a gas passageway in said single cell which it is arranged so that it may adjoin mutually, and said crevice of ******** forms, It connects with said gas supply manifold and said gas exhaust manifold in both ends of said crevice which makes U type, Said gas supply manifold with which each of two or more of said divided-flow way formation parts is provided, and said gas exhaust manifold are good also as adjoining mutually and being allocated along with one of the sides of said stack structure.

[0026]According to a fuel cell constituted using a gas separator for fuel cells of such this invention, and the fuel cell of this invention. A gas supply manifold and a gas exhaust manifold which gas of the same kind passes, It is allocated in the side of stack structure along with one, and between gas manifolds which gas of the same kind passes, since it is not necessary to secure the sealing nature of gas strictly, seal structure of a field which forms a gas manifold can be simplified. By making into U type shape of a crevice which forms a gas passageway in a single cell, Compared with a case where form a crevice in linear shape and a pore for a gas manifold is formed in the both ends, it becomes possible to use a larger field on the surface of a gas separator for a gas passageway in a single cell, and a gas separator and a fuel cell using this can be miniaturized.

[0027]In a fuel cell of such this invention, by carrying out heat exchange between insides of a fuel cell, A cooling fluid way where heat produced in connection with said electrochemical reaction was removed, and temperature inside a fuel cell is a channel which makes the inside pass cooling fluid which prevents going up to a non-wanting temperature, and was provided in two or more predetermined positions inside a fuel cell, . It is formed in a laminating direction of said stack structure, and distribute said cooling fluid to said cooling fluid way. Or have a cooling fluid manifold with which said cooling fluid which passed through said each cooling fluid way gathers, and said cooling fluid manifold, It is provided near said gas supply manifold which adjoined mutually and was provided along with one of the sides which form said stack structure, and said gas exhaust manifold, It is better also as having been provided in a position which is distant from a place in which a gas passageway in said single cell is formed than a position in which said gas supply manifold and said gas exhaust manifold were allocated.

[0028]If it has such composition, in order to allocate a cooling fluid manifold in a position which is distant from a place in which a gas passageway in said single cell is formed rather than a position in which said gas supply manifold and said gas exhaust manifold were allocated, A fuel cell can be effectively miniaturized about a predetermined direction (the direction of [between the sides in which a gas supply manifold and a gas exhaust manifold are not allocated]).

[0029]A gas separator for fuel cells of this invention, Said two or more crevices which equip both sides of said gas separator for fuel cells with a flow path forming part in a single cell of said plurality, and are formed on one field of said gas separator for fuel cells, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator for fuel cells, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell which are arranged so that it may adjoin mutually, and were formed on one field of said gas separator for fuel cells, respectively, Along the 1st peripheral area of said gas separator for fuel cells, it is arranged so that it may adjoin mutually, The aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell formed on a field of another side of said gas separator for fuel cells, respectively is good also as being arranged along the 1st

peripheral area of said gas separator for fuel cells, and the 2nd peripheral area that counters, so that it may adjoin mutually.
[0030]Similarly in a fuel cell of this invention said gas separator, Said two or more crevices which have said two or more crevices to the both sides, respectively, and are formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And either of the gas passagewaies in said single cell which said two or more crevices which are arranged so that it may adjoin mutually, and were formed on one field of said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold, Along the 1st side of said stack structure, it is allocated so that it may adjoin mutually, Either of the gas passagewaies in said single cell which said two or more crevices formed on a field of another side of said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold meet the 1st side of said stack structure, and the 2nd side that counters, It is good also as being allocated so that it may adjoin mutually.
[0031]According to a fuel cell constituted using a gas separator for fuel cells of such this invention, and the fuel cell of this invention. Since a gas supply manifold and a gas exhaust manifold which gas of the same kind passes are allocated in the side of stack structure along with one like the above-mentioned composition, Since a larger field on the surface of a gas separator can be used for a gas passageway in a single cell while being able to simplify seal structure of a field which forms a gas manifold, an effect that a gas separator and a fuel cell using this can be miniaturized can be acquired. A gas manifold which a gas passageway in a single cell formed on one field of a gas separator opens for free passage, With a gas manifold which a gas passageway in a single cell formed on a field of another side of a gas separator opens for free passage. Since it is formed along the side which counters mutually, in a fuel cell, distance between the sides in which a gas manifold is not formed can be effectively made small, and the whole fuel cell can be miniaturized more.
[0032]Said gas supply manifold with which said divided-flow way formation part is provided in a fuel cell of this invention, As opposed to a gas passageway in said single cell formed in said all single cells with which said stack structure was equipped, Said gas exhaust manifold which supplies said gas simultaneously and with which said divided-flow way formation part is provided is good also as said gas simultaneously discharged from a gas passageway in said single cell formed in said all single cells with which said stack structure was equipped gathering. If it has such composition, structure of a gas manifold can be simplified.
[0033]It is formed in a laminating direction of said stack structure in a fuel cell of this invention, Have two or more tubular structure committed as said gas supply manifold or said gas exhaust manifold, and at least one of said the tubular structure. In said single cell which has a blocking section which intercepts a flow of gas which passes an inside in an internal position, and was allocated in it by the upstream of a flow of said gas rather than said blocking section. Said tubular structure which has said blocking section is used as said gas supply manifold, Said gas is simultaneously supplied to each of a gas passageway in said single cell with which said single cell allocated in said upstream is provided, In said single cell allocated in the downstream of a flow of said gas rather than said blocking section. It is good also as supplying said gas simultaneously to each of a gas passageway in said single cell with which said single cell which used said tubular structure committed as said gas exhaust manifold by the upstream as said gas supply manifold, and was allocated in said downstream rather than said blocking section is provided.

[0034]If it has such composition, gas supplied to stack structure will be simultaneously supplied to a gas passageway in a single cell with which a single cell arranged at the upstream of a flow of gas is provided rather than a blocking section. Gas discharged from a single cell arranged at these upstream is supplied to a gas passageway in a single cell with which a single cell arranged rather than a blocking section at the downstream is provided by making into a gas supply manifold the tubular structure committed as a

gas exhaust manifold in the upper stream rather than a blocking section. Therefore, compared with composition which supplies gas to a gas passageway in a single cell with which all the single cells which constitute stack structure are provided simultaneously, gas volume supplied to each gas passageway in a single cell increases, and the rate of flow of gas in a channel can be sped up. Thus, it is realizable by easy composition of providing a blocking section in the tubular structure which constitutes a manifold for an effect of increasing gas volume in a channel.

[0035]In a fuel cell of this invention, after said gas to which said stack structure which this fuel cell equips with said two or more divided-flow way formation parts is supplied by two or more preparations and said fuel cell is divided beforehand, it is good also as being supplied to each of two or more of said stack structures. Also in this case, since each stack structure is provided with two or more divided-flow way formation parts as a channel where said gas passes an inside, in each stack structure, an effect by a flow of gas which passes a gas passageway in a single cell increasing mentioned already is acquired.

[0036]Or in a fuel cell of this invention this fuel cell, Said gas to which said stack structure provided with said two or more divided-flow way formation parts was supplied by one of predetermined [the / of two or more preparations and said two or more stack structures], While passing said two or more divided-flow way formation parts with which stack structure predetermined [this] is provided one by one, it is good also as going via said divided-flow way formation part with which said different stack structure from said predetermined stack structure is provided.

[0037]Also in this case, since each stack structure is provided with two or more divided-flow way formation parts as a channel where said gas passes an inside, in each stack structure, an effect by a flow of gas which passes a gas passageway in a single cell increasing mentioned already is acquired. Since gas supplied to a fuel cell passes a divided-flow way formation part with which two or more stack structures are provided respectively one by one, after it divides a flow of gas beforehand, it can reduce a number which divides a flow of gas into each stack structure by an upstream part compared with a case where gas is supplied. By this, a gas mass flow which passes a gas passageway in a single cell can be increased further, and accuracy which divides a flow of gas can be raised. When accuracy which divides a flow of gas improves, gas volume supplied to each stack structure can be equalized more, and an output in each stack structure can be equalized.

[0038]

[Embodiment of the Invention]In order to clarify further composition and an operation of this invention explained above, an embodiment of the invention is described based on an example below. The fuel cell which is the 1st example of this invention is a polymer electrolyte fuel cell, and is formed of the stack structure which carried out the plural laminates of the single cell. The top view showing the composition of the separator 30 with which the fuel cell of this example is provided with the exploded perspective view showing the composition of the single cell 20 which is a basic unit of the stack structure 15 from which drawing 1 constitutes the fuel cell of the 1st example, and drawing 2, and drawing 3 are the perspective views showing the appearance of the stack structure 15. First, based on drawing 1 thru/or drawing 3, the composition of a fuel cell is explained, next the situation of the flow of the gas in this fuel cell is explained.

[0039]As mentioned above, the fuel cell of this example is a polymer electrolyte fuel cell, and is constituted by the stack structure 15 which laminated the single cell 20 which is a basic unit. As shown in drawing 1, the single cell 20 is constituted by the electrolyte membrane 31, the anode 32, the cathode 33, and the separator 30.

[0040]Here, the electrolyte membrane 31 is an ion-exchange membrane of the proton conductivity formed with solid polymer material, for example, fluororesin, and shows good electrical conductivity according to a damp or wet condition. In this example, the Nafion film (made by Du Pont) was used. The alloy which consists of platinum as a catalyst or platinum, and other metal is applied to the surface of the electrolyte membrane 31. The carbon powder which supported the alloy which consists of platinum or platinum, and other metal as a method of applying a catalyst is produced, The suitable organic solvent was made to distribute the carbon powder which supported this catalyst, a proper quantity of electrolytic solutions (for example, Aldrich Chemical, Nafion Solution) were added and

pasted, and the method of screen-stenciling on the electrolyte membrane 31 was taken. Or the composition which carries out film shaping of the paste containing the carbon powder which supported the above-mentioned catalyst, produces a sheet, and presses this sheet on the electrolyte membrane 31 is also preferred.
[0041]Both the anode 32 and the cathode 33 are formed by the carbon crossing woven with the thread which consists of carbon fiber. In this example, although the anode 32 and the cathode 33 were formed by carbon crossing, the composition formed by the carbon paper or carbon felt which consists of carbon fiber is also preferred.
[0042]The separator 30 is formed by the gas unpenetrated conductive member, for example, the substantia-compacta carbon which compressed carbon and it presupposed gas un-penetrating. Drawing 2 (A) and (B) is a top view showing signs that the separator 30 was seen from double-sided each. The separator 30 is provided with ten holes near [the] the circumference. That is, the pores 40, 41, and 42 which are three holes which adjoin along with this neighborhood are formed near the one side of the separator 30, and the pores 43, 44, and 45 which similarly adjoin are formed near the neighborhood which counters around here. The pore 50 and the pore 51 which are two holes which adjoin along with this neighborhood are provided near [which is different in the two above-mentioned sides] the one side, and the pore 52 and the pore 53 which similarly adjoin are provided near the neighborhood which counters around here (refer to drawing 2). The separator 30 is provided with the grooved rib formed in parallel with the both sides.
[0043]The rib part 55 is the same with the pore 41, this and the pore 44 which counters are connected, in respect of one of the two of the separator 30, the pore 40, and this and the pore 43 which counters are connected here, and the rib part 57 is formed [the rib part 56 is the same with the pore 42, this and the pore 45 which counters are connected, and]. In respect of another side of the separator 30, the pore 50, and this and the pore 52 which counters are connected, the rib part 58 connects the pore 51, and this and the pore 53 which counters, and the rib part 59 is formed. Each of these rib parts are making a parallel grooved structure mutually, as described above.
[0044]As shown in drawing 1, when the separator 30 is laminated with the electrolyte membrane 31, the anode 32, and the cathode 33, forms the single cell 20 and constitutes the stack structure 15 further, each rib part forms a gas passageway between adjoining gas diffusion electrodes. Namely, the rib parts 55-57 which connect two pores countered of the pores 40-45, The rib parts 58 and 59 which connect two pores which form the oxidizing gas passage in a single cell between the surfaces of the adjoining cathode 33, and are countered of the pores 50-53 form the fuel gas flow route in a single cell between the surfaces of the adjoining anode 32.
[0045]When the single cell 20 is laminated and the stack structure 15 is assembled, the pores 40, 44, and 42 with which each separator 30 is provided form the oxidizing gas supply manifolds 60, 61, and 62 which penetrate stack structure 15 inside to the laminating direction, respectively. Similarly the pores 43, 41, and 45 form the oxidizing gas exhaust manifolds 63, 64, and 65 which penetrate stack structure 15 inside to the laminating direction, respectively. The pores 52 and 51 form the fuel gas supply manifolds 66 and 67 which similarly penetrate stack structure to the laminating direction, respectively, and the pores 50 and 53 form the fuel gas exhaust manifolds 68 and 69, respectively (refer to drawing 2). It explains later that the gas within these gas passagewaies formed in the stack structure 15 flows in detail (see drawing 6 and drawing 7 which are mentioned later).
[0046]When assembling the stack structure 15 provided with each member explained above, it piles up one by one in order of the separator 30, the anode 32, the electrolyte membrane 31, the cathode 33, and the separator 30, and while laminated a predetermined number of single cells 20, and the return plate 70 is arranged at the end. The stack structure 15 which arranges the collecting electrode plates 36 and 37, the electric insulating plates 38 and 39, and the end plates 80 and 85 one by one to the both ends, and is shown in drawing 3 is completed.
[0047]The return plate 70 is formed with substantia-compacta carbon like the separator 30. Drawing 4 is an explanatory view showing the shape of the return plate 70. Drawing 4 (A) expresses plane appearance and drawing 4 (B) expresses the situation of the (B)-(B) section in drawing 4 (A). As shown

in drawing 4, the return plate 70, It has the crevices 71, 72, and 74 and the pores 75, 76, 77, and 78 near [the] the periphery, and when the stack structure 15 is constituted, the return plate 70 is allocated so that the adjoining separator 30 and the field which has the crevices 71, 72, and 74 may touch. Although the situation of the section of the crevice 71 was shown in drawing 4 (B), other crevices 72 and 74 have the same structure, and each of these is the hollow structures which dug the return plate 70 surface and were established. the hole in which the pores 75-78 penetrate the return plate 70 -- it is structure.
[0048]When the crevice 71 with which the return plate 70 is provided constitutes the stack structure 15, it laps with the pore 43 and the pore 44 which the adjoining separator 30 has, and makes the end of the oxidizing gas exhaust manifold 63 mentioned already, and the end of the oxidizing gas supply manifold 61 open for free passage here. When the crevice 72 constitutes the stack structure 15, it laps with the pore 41 and the pore 42 which the adjoining separator 30 has, and makes the end of the oxidizing gas exhaust manifold 64 mentioned already, and the end of the oxidizing gas supply manifold 62 open for free passage. When the crevice 74 constitutes the stack structure 15, it laps with the pore 50 and the pore 51 which the adjoining separator 30 has, and makes the end of the fuel gas exhaust manifold 68 mentioned already, and the end of the fuel gas supply manifold 67 open for free passage similarly.
[0049]It laps with the pore 40 of the separator 30, and the opening of the end of the oxidizing gas supply manifold 60 is carried out, the pore 76 laps with the pore 45 of the separator 30, and the pore 75 carries out the opening of the end of the oxidizing gas exhaust manifold 65. It laps with the pore 52 of the separator 30, and the opening of the end of the fuel gas supply manifold 66 is carried out, the pore 78 laps with the pore 53 of the separator 30, and the pore 77 carries out the opening of the end of the fuel gas exhaust manifold 69. the oxidizing gas supply manifolds 60-62, the oxidizing gas exhaust manifolds 63-65, the fuel gas supply manifolds 66 and 67, and the fuel gas exhaust manifolds 68 and 69 -- each other end is blockaded by the collecting electrode plate 37.
[0050]the collecting electrode plates 36 and 37 -- gas, such as substantia-compacta carbon and a copper plate, -- it is formed of a conductive member [**** / un-], the electric insulating plates 38 and 39 are formed of insulation members, such as rubber and resin, and the end plates 80 and 85 are formed with metal, such as steel provided with rigidity. The output terminals 36A and 37A are formed in the collecting electrode plates 36 and 37, respectively, and an output of the electromotive force produced with the fuel cell constituted by the stack structure 15 is possible. four holes which lap with these pores 75-78 and whose formation of a gas passageway is attained at the pores 75-78 with which the return plate 70 is provided, and a corresponding position when the stack structure 15 is constituted in the collecting electrode plate 36, the electric insulating plate 38, and the end plate 80 -- structure is established, respectively. For example, corresponding to each of the pores 75-78, the pores 81-84 are formed in the end plate 80 (refer to drawing 3).
[0051]when operating the fuel cell which consists of the stack structure 15, the pore 83 with which the end plate 80 is provided, and the fuel gas feed unit which is not illustrated are connected -- hydrogen -- rich fuel gas is supplied to the inside of a fuel cell. Similarly, when operating a fuel cell, the pore 81 and the oxidizing gas feed unit which is not illustrated are connected, and the oxidizing gas (air) containing oxygen is supplied to the inside of a fuel cell. Here, a fuel gas feed unit and an oxidizing gas feed unit are devices which perform humidification and application of pressure of the specified quantity to each gas, and are supplied to a fuel cell. When operating a fuel cell, the pore 84 and the fuel gas exhaust which is not illustrated are connected, and the pore 82 and the oxidizing gas exhaust which is not illustrated are connected.
[0052]Although the built-up sequence of each member when the stack structure 15 is constituted is as having mentioned already, in the field which touches the separator 30, a predetermined sealing member is provided in the periphery of the electrolyte membrane 31. This sealing member prevents fuel gas and oxidizing gas beginning to leak from each inside of a single cell, and it plays the role which prevents fuel gas and oxidizing gas from being mixed in the stack structure 15.
[0053]The stack structure 15 which consists of each member explained above is held where predetermined thrust is applied to the laminating direction, and a fuel cell completes it. About the composition which presses the stack structure 15, since it was not concerned, the graphic display was

abbreviated to the important section of this invention. In order to hold pressing the stack structure 15, It is good also as composition which binds the stack structure 15 tight using a bolt and a nut, or the stack member housing of predetermined shape is prepared, It is good also as composition which bends the both ends of stack member housing after storing the stack structure 15 inside this stack member housing, and makes thrust act on the stack structure 15.

[0054]In the above-mentioned explanation, although it presupposed that the separator 30 and the return plate 70 are formed with the substantia-compacta carbon which compressed carbon and it presupposed gas un-penetrating, they are good also as forming according to different construction material. For example, it is good also as forming with baking body carbon or forming by a metallic member. When forming by a metallic member, it is desirable to choose the metal which has sufficient corrosion resistance. Or it is good also as covering the surface of a metallic member with the construction material which has sufficient corrosion resistance.

[0055]Although drawing 2 did not indicate, The separator 30 of this example is provided also with the pore for forming the cooling water manifold which cooling water other than the pores 40-45 for forming the gas manifold which oxidizing gas passes, and the pores 50-53 for forming the gas manifold which fuel gas passes passes. Although the chemical energy in the fuel supplied to a fuel cell is changed into electrical energy in the electrochemical reaction which advances with a fuel cell, conversion to electrical energy from chemical energy is not necessarily performed thoroughly, and the remaining energies that were not changed into electrical energy are released as heat. Thus, in order to continue generation of heat with power generation and to carry out the operating temperature of a fuel cell desirable within the limits, the fuel cell usually provided the channel of cooling water in the fuel cell, and has removed excessive heat by passing cooling water in a fuel cell.

[0056]When members, such as a separator mentioned already, are laminated and the stack structure 15 is constituted, this pore with which the separator 30 is provided forms the cooling water manifold which penetrates the inside of the stack structure 15 and carries out the feeding and discarding of the cooling water to the circulating-water-flow way between single cells mentioned later. In the stack structure 15 which constitutes such a fuel cell, it has a cooling channel separator which forms in the surface the rugged structure which forms the channel of cooling water instead of the usual separator 30 for every single cell of the laminated predetermined number (not shown). The rugged structure formed on this cooling channel separator forms the circulating-water-flow way between single cells between a cooling channel separator and the member which adjoins this. This circulating-water-flow way in a stack arranged for every single cell of a predetermined number received the feeding and discarding of cooling water from the cooling water manifold which consists of the above-mentioned pore, and has removed the excessive heat produced with power generation with this cooling water out of the fuel cell.

[0057]Next, it explains that the fuel gas in the fuel cell provided with the above composition and oxidizing gas flow. First, oxidizing gas is explained. The explanatory view and drawing 7 to which drawing 6 expresses the flow of the oxidizing gas within the stack structure 15 in three dimensions are the explanatory view which similarly expressed the flow of oxidizing gas superficially. As mentioned already, the oxidizing gas feed unit formed in the fuel cell exterior, The oxidizing gas (application-of-pressure air) which is connected to the pore 81 provided in the end plate 80, and is supplied from an oxidizing gas feed unit, It is introduced in the oxidizing gas supply manifold 60 via the pore provided in the position to which the electric insulating plate 38 and the collecting electrode plate 36 correspond, and the pore 75 provided in the return plate 70. The oxidizing gas which passes through the inside of the oxidizing gas supply manifold 60 is drawn in each single cell 20 in the gas passageway (oxidizing gas passage in a single cell) formed between the cathodes 33 which adjoin the rib part 55 in each separator 30. Although electrochemical reaction is presented with the oxidizing gas led to the oxidizing gas passage in these single cells in each single cell, the remaining oxidizing gas that did not participate in a reaction is discharged by the oxidizing gas exhaust manifold 63 formed of the pore 43 provided in the separator 30. In the oxidizing gas exhaust manifold 63, in the oxidizing gas supply manifold 60, while oxidizing gas passes for reverse, the oxidizing gas discharged from the oxidizing gas passage in a single cell formed in each single cell is joined.

[0058]If such oxidizing gas reaches the return plate 70 of stack structure 15 end, it will be further drawn by the crevice 71 in the oxidizing gas supply manifold 61. The oxidizing gas drawn in the oxidizing gas supply manifold 61, It is distributed to each oxidizing gas passage in a single cell formed between the cathodes 33 which adjoin the rib part 56 in each separator 30, and electrochemical reaction is presented, passing through the oxidizing gas passage in this single cell, passing through the inside of this oxidizing gas supply manifold 61. Thus, the oxidizing gas which passed through the oxidizing gas passage in a single cell is discharged by the oxidizing gas exhaust manifold 64, in the oxidizing gas supply manifold 61, joins flowing for reverse and reaches the return plate 70 again.
[0059]In the return plate 70, oxidizing gas is led to the crevice 72 and introduced into the oxidizing gas supply manifold 62. In the oxidizing gas supply manifold 62, similarly oxidizing gas, It is distributed to each oxidizing gas passage in a single cell formed between the cathodes 33 which adjoin the rib part 57 in each separator 30, and electrochemical reaction is presented, passing through the oxidizing gas passage in this single cell, passing through the inside of this oxidizing gas supply manifold 62. Thus, the oxidizing gas which passed through the oxidizing gas passage in a single cell is discharged by the oxidizing gas exhaust manifold 65, joins, in the oxidizing gas supply manifold 62, flows for reverse and reaches the return plate 70 again. The oxidizing gas which reached the return plate 70 is discharged by the oxidizing gas exhaust linked to this pore 82 via the pore 76 of the return plate 70, the pore provided in the position to which the collecting electrode plate 36 and the electric insulating plate 38 correspond, and the pore 82 provided in the end plate 80.
[0060]As mentioned above, although it explained that the oxidizing gas within the stack structure 15 flowed, the same may be said of the fuel gas within the stack structure 15 flowing. Drawing 8 is the explanatory view which expressed superficially the flow of the fuel gas within the stack structure 15. As mentioned already, the fuel gas feed unit formed in the fuel cell exterior, The fuel gas which is connected to the pore 83 provided in the end plate 80, and is supplied from a fuel gas feed unit is introduced in the fuel gas supply manifold 66 via the pore provided in the position to which the electric insulating plate 38 and the collecting electrode plate 36 correspond, and the pore 77 provided in the return plate 70. The fuel gas which passes through the inside of the fuel gas supply manifold 66 is drawn in each single cell 20 in the gas passageway (fuel gas flow route in a single cell) formed between the anodes 32 which adjoin the rib part 58 in each separator 30. Although electrochemical reaction is presented with the fuel gas led to the fuel gas flow route in these single cells in each single cell, the remaining fuel gas that did not participate in a reaction is discharged by the fuel gas exhaust manifold 68 via the pore 50 provided in the separator 30. In the fuel gas exhaust manifold 68, in the fuel gas supply manifold 66, while fuel gas passes for reverse, the fuel gas discharged from the fuel gas flow route in a single cell formed in each single cell is joined.
[0061]If such fuel gas reaches the return plate 70 of stack structure 15 end, it will be further drawn by the crevice 74 in the fuel gas supply manifold 67. The fuel gas drawn in the fuel gas supply manifold 67, It is distributed to each fuel gas flow route in a single cell formed between the anodes 32 which adjoin the rib part 59 in each separator 30, and electrochemical reaction is presented, passing the fuel gas flow route in this single cell, passing through the inside of this fuel gas supply manifold 67. Thus, the fuel gas which passed the fuel gas flow route in a single cell is discharged by the fuel gas exhaust manifold 69, in the fuel gas supply manifold 67, joins flowing for reverse and reaches the return plate 70 again. The fuel gas which reached the return plate 70 is discharged by the fuel gas exhaust linked to this pore 84 via the pore 78 of the return plate 70, the pore provided in the position to which the collecting electrode plate 36 and the electric insulating plate 38 correspond, and the pore 84 provided in the end plate 80.
[0062]In [according to the fuel cell of this example constituted as mentioned above] the surface of each separator 30, Since the field in which the channel of oxidizing gas and fuel gas is formed was divided into 3 and 2, respectively and the gas supply manifold and the gas exhaust manifold are independently provided corresponding to each of the divided field, Even if the gas mass flow supplied to the whole fuel cell is the same, compared with the conventional composition which does not divide the field in which a channel is formed, the gas mass flow per [in the gas passageway in a single cell] unit sectional area is increased, and a gas flow rate can be raised. For example, when the rib parts 55, 56, and 57 have divided

into three equally the field which can form the oxidizing gas passage in a single cell in the separator 30, respectively. Even if the gross area which forms the rib part in the separator surface is the same as the flow of the oxidizing gas supplied to a fuel cell from an oxidizing gas feed unit, compared with the case where the separator 130 shown in drawing 32 is used, the flow of the oxidizing gas which passes through the inside of the oxidizing gas passage in a single cell increases 3 times.

[0063]Therefore, by dividing the field in which a gas passageway is formed, within a gas passageway, gas is stirred well and will be in the state where it is spread. By this, the catalyst and electrode active material with which the electrode was equipped contact easily, the electrode active material in gas can be carried out that it is easy to be used by electrochemical reaction, and the capacity factor of gas can be raised. If the capacity factor of gas improves, even if it reduces conventionally the total amount of the gas supplied to a fuel cell from a fuel gas feed unit or an oxidizing gas feed unit, it will become possible to fully advance electrochemical reaction. Therefore, about fuel gas, the effect that the amount of consumption of fuel can be stopped is acquired. It is effective when using especially the reformed gas which obtained hydrocarbon by reforming it with a steam reforming process etc. as fuel gas. That is, into reformed gas, since many ingredients which do not contribute to any electrochemical reaction other than hydrogen are contained, in order to fully advance electrochemical reaction, compared with the case where hydrogen gas is used as fuel gas, it is necessary to supply the reformed gas containing more hydrogen as fuel gas. By raising the capacity factor of gas by composition of this example, the amount of reformed gas supplied to a fuel cell can be stopped, and the effect which reduces the amount of consumption of fuel can be acquired more notably.

[0064]By becoming possible to stop the total amount of the gas supplied to a fuel cell, about oxidizing gas. The amount of energy consumed in order to pressurize this oxidizing gas, when supplying oxidizing gas to a fuel cell is stopped, and the effect that the energy efficiency of the whole system provided with a fuel cell can be maintained in the high state is acquired. Are the composition to which the gas mass flow which passes the gas passageway in a single cell is made to increase here, and the shape of the gas passageway formed in the separator surface with the composition which is made into picture-drawn-without-lifting-the-brush-from-the-paper structure and which was mentioned already. Since it is necessary to bend the shape of the gas passageway in a single cell, although the total amount of the gas which the pressure loss at the time of gas passing through the inside of this gas passageway is large, and supplies to a fuel cell does not increase, the inconvenience that the amount of energy consumed in order to pressurize the gas supplied to a fuel cell increases is produced. In the composition of this example, since it is not necessary to bend the gas passageway in a single cell, the problem of such a pressure loss does not become large.

[0065]The effect that the wastewater nature in a fuel cell can be raised is acquired by making quick the rate of flow of the gas which passes through the inside of a gas passageway. Here, the problem of the produced water in a fuel cell is explained. When a fuel cell advances electrochemical reaction in response to supply with the fuel gas containing hydrogen, and the oxidizing gas containing oxygen, produced water arises. The formula which expresses below the electrochemical reaction which advances with a fuel cell is shown.

[0066]

$H_2 \rightarrow 2H^+ + 2e^-$ -- (1)

$(1/2)\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$ -- (2)

$H_2 + (1/2)\ O_2 \rightarrow H_2O$ -- (3)

[0067](1) The reaction which expresses the reaction for which (2) types advance the reaction for which a formula advances by the anode side by the cathode side, and is expressed to (3) types as a whole advances. (2) As shown in the formula, in the cathode side, produced water arises with advance of electrochemical reaction, but this produced water is usually evaporated in oxidizing gas, and is discharged with oxidizing gas. At this time, when there are many generated amounts of produced water, produced water may stagnate into a gas diffusion electrode, without the ability to fully evaporate in

oxidizing gas, and may produce the inconvenience of barring diffusion of gas [/ near the catalyst on an electrolyte membrane]. In a fuel cell provided with the separator 30 of this example. Since the produced water produced in the cathode side since the rate of flow of the oxidizing gas which passes the gas passageway in a single cell became quick as described above is evaporated efficiently and discharged in oxidizing gas, it can be prevented from produced water stagnating inside a fuel cell and barring diffusion of gas.

[0068]The effect that the humidifying amount to the oxidizing gas supplied to a fuel cell can be reduced is also acquired by the ability to reduce the total amount of the gas supplied to a fuel cell. As described above, produced water arises in the cathode side, but a part of moisture which electrolyte membranes including this produced water hold is evaporated in oxidizing gas, and it is discharged out of a fuel cell. In order to fully advance electrochemical reaction in a fuel cell, usually supply the oxidizing gas which contains much oxygen rather than the amount of oxygen needed for a theoretical target to a fuel cell, but. Since the moisture content carried out from the inside of a fuel cell by oxidizing gas increased so that the amount of oxidizing gas supplied to a fuel cell increases, conventionally, the oxidizing gas supplied to a fuel cell was humidified beforehand, and desiccation of the electrolyte membrane had been prevented. In a fuel cell provided with the separator 30 of this example, since the total amount of the gas supplied to a fuel cell can be reduced, the moisture content carried out out of a fuel cell by oxidizing gas can be lessened more, and the effect that the humidifying amount of the oxidizing gas supplied to a fuel cell can be reduced is done so. By the ability to reduce a humidifying amount, the energies which humidification takes are reducible. Although the moisture content taken from an electrolyte membrane by oxidizing gas changes by the operating temperature of a fuel cell, a pressure, the rate of flow of oxidizing gas, etc., If damp or wet condition with a sufficient electrolyte membrane is maintainable even if it does not perform humidification to a fuel cell, it is possible to make unnecessary composition which humidifies oxidizing gas. In the anode side, to use hydrogen gas as fuel gas, before supplying a fuel cell, it is necessary to humidify this fuel gas, in order for the proton produced at the reaction of (1) type to move in the state where it hydrated with the water molecule in the inside of an electrolyte membrane but, and. The humidifying amount to fuel gas can also be lessened by stopping the fuel gas amount supplied to a fuel cell.

[0069]Here, the effect of becoming possible to set up the operating temperature of a fuel cell more highly is also acquired by reducing the total amount of the gas supplied to a fuel cell, and being able to reduce the moisture content taken from an electrolyte membrane by such gas. That is, when the moisture content which the gas volume supplied to a fuel cell becomes less, and is taken from an electrolyte membrane becomes less, it becomes possible also under an elevated temperature with higher maximum vapor tension to operate a fuel cell, without an electrolyte membrane getting dry too much. By setting up the operating temperature of a fuel cell more highly, electrochemical reaction can be activated more. When using the reformed gas especially mentioned already by setting up the operating temperature of a fuel cell more highly as fuel gas, it can stop that the catalyst on an electrolyte membrane receives poisoning with the carbon monoxide in reformed gas, and battery capacity can be raised more. carrying out steam reforming of the hydrocarbon -- hydrogen -- when generating rich reformed gas, there is a possibility that a small amount of carbon monoxide may be generated, and such carbon monoxide sticks to the catalyst on an electrolyte membrane, and reduces catalyst performance. It is dependent on temperature and the grade of poisoning by carbon monoxide can suppress the grade of poisoning by setting up the operating temperature of a fuel cell more highly.

[0070]In a fuel cell provided with the separator 30 of this example. It corresponds to each of the field which the field (field in which the gas passageway in a single cell is formed) to which oxidizing gas or fuel gas is supplied is divided in the arbitrary single cells 20, and was divided, Since the gas supply manifold and the gas exhaust manifold are provided independently, Also when produced water stagnates in the terminal area of a specific manifold and the specific channel in a single cell, supply of the gas to this single cell is not severed thoroughly, and the effect that there is no possibility that generation efficiency may fall by the whole single cell is acquired. As mentioned above, when electrochemical reaction advances with a fuel cell, produced water arises in the cathode side, and the produced produced

water is evaporated and discharged in oxidizing gas, but. Inside a fuel cell, in the field where a temperature distribution state is comparatively low, the water vapor content which exceeds the water vapor content corresponding to maximum vapor tension will exist, and condensation of produced water may break out. If this water of condensation stagnates in the terminal area of a manifold and the channel in a single cell when condensation of such produced water breaks out, supply of the gas to the gas passageway in this single cell will be intercepted. If the above-mentioned terminal area is blockaded with produced water when the number of the manifolds which supply gas to the gas passageway in a single cell formed on a separator like the separator 130 shown in drawing 32 is one, supply of the gas to the single cell corresponding to this terminal area will stop thoroughly. In a fuel cell provided with the separator 30 of this example. Every three manifolds which supply oxidizing gas to the gas passageway in a single cell formed on a separator are formed independently, A possibility that these three terminal areas will be blockaded simultaneously is very low, and it can be prevented from supply of the oxidizing gas to either of the single cells which constitute stack structure originating in produced water, and stopping thoroughly.

[0071]The gas volume supplied to each single cell 20 which constitutes the stack structure 15 does so the effect of being equalized more with the whole fuel cell, by dividing the field in which the gas passageway in a single cell is formed. Usually, the quantity of the gas distributed to the gas passageway in each single cell from a gas supply manifold shows dispersion for every single cell. By the gas passageway in a single cell in each single cell, distribution of a gas mass flow shows dispersion. Namely, in the fuel cell constituted using the separator 130 as shown in drawing 32. A gas mass flow does not serve as homogeneity by the whole gas passageway in a single cell which the rib part 155 forms, but a field with few gas mass flows is especially formed in the both ends (near the end of the right and left of the rib part 155 shown in drawing 32) of the rib part 155. Thus, within the gas passageway in a single cell, Or since the flow of gas shows dispersion for every gas passageway in a single cell, so that electrochemical reaction may fully advance also in the field corresponding to a channel with few gas mass flows usually, The gas volume supplied to the whole fuel cell was set as sufficient quantity, and the gas volume supplied to the gas passageway in each single cell was fully secured.

[0072]Since the field in which the gas passageway in a single cell is formed is divided within each single cell in the fuel cell of this example, Although dispersion in the flow of gas arises in each divided field (inside of the gas passageway in a single cell which each of two or more rib parts with which the separator 30 is provided on the same side forms), in the whole gas passageway in a single cell formed on the predetermined field, influence of dispersion in a gas mass flow can be made smaller. Namely, dispersion of the gas mass flow in each divided field, As opposed to each field which produced independently and was divided, respectively, Since gas is supplied independently, respectively, in each divided fields of all, a possibility that the flow of gas will decrease compared with other gas passagewaies in a single cell is low, and its a possibility that a gas mass flow may decrease extremely in the gas passageway in a single cell in a specific single cell decreases. There is a possibility that a field with few above-mentioned gas mass flows may become large far compared with the composition which divides the composition which passes gas at once to a large field like the gas passageway in a single cell which the separator 130 shown in drawing 32 forms, depends, and supplies gas to a narrow field separately. Therefore, in the gas passageway in each single cell, the field whose gas mass flow decreases can be made smaller by dividing the gas passageway in a single cell like this example. Thus, in order to fully advance electrochemical reaction in the field whose gas mass flow decreases with dispersion in a gas mass flow since dispersion in the flow of the gas which passes the gas passageway in a single cell can be made small and a gas mass flow can fully be secured, It becomes unnecessary to supply superfluous gas to a fuel cell, and the amount of consumption of gas is stopped, and it becomes possible to reduce the amount of energy consumed in order to supply gas to a fuel cell.

[0073]Although the concentration of the electrode active material contained by using an electrode active material for electrochemical reaction in the process in which the inside of a fuel cell is passed will fall gradually, the gas supplied to the fuel cell, In the fuel cell of this example, the gas passageway provided

with the divided gas passageway in a single cell is connected one by one, and gas with low electrode active material concentration is not supplied only to a specific single cell. Instead of dividing the field which forms the gas passageway in a single cell like this example, divide into plurality the stack structure which constitutes a fuel cell, and also as composition which connects the divided stack structure in series, Although the gas volume which passes the gas passageway in a single cell can be increased on the conditions that the gas volume supplied to a fuel cell is certain, there is a divided possibility that a difference may arise in generation efficiency for every single cell, in this case. Namely, if two stack structures which laminated 50 single cells are connected in series instead of laminating 100 single cells and forming stack structure, Instead of being divided into 100, the gas of the specified quantity supplied to the fuel cell will be divided into 50, will be supplied to each gas passageway in a single cell, and can acquire the effect of increasing a gas mass flow and raising the rate of gas utilization. However, since the electrode active material concentration in the gas supplied compared with the upstream becomes low and the whole gas volume of stack structure of the downstream also decreases, the stack structure of the downstream has a possibility that dispersion in performances, like voltage becomes low compared with the upstream may arise. Even if dispersion in the performance of the stack structure of such the upstream and the stack structure of the downstream increases the number of single cells with which the stack structure of the upstream is provided compared with the downstream, it is difficult to cancel. There is no possibility that battery capacity may fall selectively and may differ in the fuel cell of this example since gas with low electrode active material concentration is not supplied or a gas mass flow does not decrease in a specific single cell.

[0074]In each single cell, the field in which the gas passageway in a single cell is formed is divided into plurality, and the example which actually checked the effect acquired by the composition of the fuel cell of this example of providing independently the gas manifold which supplies gas to each field is shown below. Drawing 9 is an explanatory view showing the situation of dispersion in the voltage in each single cell which constitutes a fuel cell when output current density from a fuel cell is fixed. Drawing 9 (A) expresses dispersion in the voltage in the fuel cell constituted using the separator 30 of this example, and drawing 9 (B) expresses dispersion in the voltage in the fuel cell constituted using the separator 130 shown in drawing 32. The left-hand side (entrance side) in a figure is a connection side with a gas supply device, and has indicated the voltage in each single cell one by one according to the laminating direction of a single cell toward right-hand side.

[0075]As shown in drawing 9, according to the fuel cell using the separator 30 of this example, in the whole fuel cell, the voltage stable in each single cell can be obtained. On the other hand, the output voltage value of each single cell differed in the fuel cell using the separator 130 greatly. In drawing 9, drawing 9 (A) expresses the result of having operated the fuel cell at 75 **, and drawing 9 (B) expresses the result of having operated the fuel cell at 67 **. Thus, in the fuel cell using the separator 30 of this example, even if it makes the operating temperature higher, the inconvenience that an electrolyte membrane will dry and battery capacity will fall is not produced.

[0076]Drawing 10 sets constant the output current density from a fuel cell, and expresses temporally the situation of the output voltage in each single cell which constitutes a fuel cell when changing gradually the amount of oxidizing gas (application-of-pressure air) supplied to a fuel cell. Drawing 10 (A) expresses the situation of the change of potential in the fuel cell constituted using the separator 30 of this example, and drawing 10 (B) expresses the situation of the change of potential in the fuel cell constituted using the separator 130 shown in drawing 32. The amount of oxidizing gas supplied to a fuel cell was expressed with what time [of the amount of oxygen needed for a theoretical target based on the output current density from a fuel cell] oxygen the air containing was supplied. The air which contains twice as many oxygen as the amount of oxygen needed for a theoretical target at the time of a measurement start is supplied (in drawing 10, it expressed S:2), If it is made to decrease by 1.5 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed on a theoretical target after predetermined time progress (it expressed S:1.5 in drawing 10) and further predetermined time passes, It was made to decrease by 1.25 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target.

[0077]As shown in drawing 10 (A), in the fuel cell constituted using the separator 30 of this example. Even if it made it decrease from the twice of the quantity for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target to [1.25 times], the output voltage value from each single cell which constitutes a fuel cell was able to be maintained at the state where it was stabilized. On the other hand, in the fuel cell constituted using the separator 130 shown in drawing 32. Even if the amount of oxygen in the oxidizing gas supplied to a fuel cell is twice the quantity needed for a theoretical target, The output voltage of each single cell which constitutes a fuel cell varied greatly, and when it was made to decrease by 1.5 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target, it originated in dryness of an electrolyte membrane, voltage plunged, and it was not able to continue power generation.
[0078]Thus, it was shown by by constituting a fuel cell using the separator 30 of this example that the amount of oxygen of oxidizing gas in the oxidizing gas supplied to a fuel cell, i.e., the amount supplied to a fuel cell, can be reduced substantially. In the fuel cell provided with the composition 130 of the fuel cell known conventionally, i.e., the separator of drawing 32, here. In order to maintain the output voltage fully stable in each single cell which constitutes a fuel cell, it needed to carry out by 4 to 5 times the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target. Drawing 10 (A) expresses the result of having operated the fuel cell provided with the separator 30 at 75 **, and drawing 10 (B) expresses the result of having operated the fuel cell provided with the separator 130 at 67 **. Thus, in the fuel cell using the separator 30 of this example, an operating temperature is set up more highly, and even if it lessens more the amount of oxygen in the oxidizing gas supplied to a fuel cell, i.e., the flow of oxidizing gas to supply, it becomes possible to be stabilized and to maintain the output voltage from each single cell.
[0079]Although the field in which the oxidizing gas passage in a single cell is formed was divided into three in the arbitrary single cells 20 and it presupposed that the field in which the fuel gas flow route in a single cell is formed is divided into two in the separator 30 mentioned above, it is good also as dividing into a number different, respectively. By dividing into plurality the field in which the gas passageway in a single cell is formed, and forming independently the manifold which carries out the feeding and discarding of the gas to each divided field, The rate of flow of the gas which passes the gas passageway in a single cell can be sped up, and the effect which made it easy to reach the catalyst on an electrolyte membrane for, and described above the electrode active material in gas can be acquired. Here, the rate of flow of the gas which passes through the channel in a single cell becomes quick so that the number which divides the field in which the channel in a single cell is formed is increased, but the pressure loss at the time of gas passing through a channel will increase by increasing the number of partitions. When the pressure loss at the time of gas passing through a channel becomes large, in order to secure the gas volume supplied to a fuel cell to the specified quantity, it is necessary to increase the amount of energy consumed in order to pressurize the gas supplied to a fuel cell. Therefore, it is desirable to set up the above-mentioned number of partitions so that the whole energy efficiency may not fall in consideration of the size of the effect by increasing the number which divides the field in which the channel in a single cell is formed, and the increment of the amount of energy consumed in order to pressurize the gas supplied to a fuel cell. Although we decided to divide into two or three equally the field in which the channel in a single cell is formed in the separator 30 shown in drawing 1 and drawing 2, you may divide so that it may become an area different, respectively.
[0080]In the separator 30 mentioned above, although the rib parts 55-59 were formed in the groove formed in parallel, they can also be made into different shape. As the example, the composition of one surface of the separator 30A which is a modification of the separator 30 is shown in drawing 5. Here, except the shape of the structure corresponding to the rib parts 55-57, the separator 30A has the structure which is common in the separator 30, and gave the same number to a common structure. The uneven parts 55A, 56A, and 57A are formed in the separator 30A as a structure of connecting the pores which counter. These uneven parts 55A-57A have structure which has arranged the heights of a section quadrangle in all directions on the concave surface which connected the pore which counters and was formed. In addition, what is necessary is just to have the shape whose formation is attained between

adjoining gas diffusion layers in the gas passageway in a single cell which gas passes from a predetermined pore toward this and the pore which counters as rugged structure which connects the pore which counters, when stack structure is constituted.

[0081]In the example mentioned already, as shown in drawing 6 thru/or drawing 8, the flow direction of the gas which passes an inside is reverse by the predetermined oxidation (fuel) gas supply manifold and the oxidation (fuel) gas exhaust manifold corresponding to this, but. The flow direction of the gas in these gas manifolds is good also as composition which becomes the same. Such composition is shown below. Drawing 11 using the separator 30 Each oxidation (fuel) gas supply manifold, It is an explanatory view which expresses superficially the situation of the flow of oxidizing gas when the flow of the gas which passes the inside of the oxidation (fuel) gas exhaust manifold corresponding to this constitutes the stack structure 115 which becomes the same.

[0082]Since it has the composition which is common in the stack structure 15 of the 1st example except the return plate, the stack structure 115 gives the same number to a common member, and omits detailed explanation. In the stack structure 115, the return plate 90 is allocated by one end and the return plate 95 is allocated by the end of another side. The top view showing signs that it saw from the field of the side which touches the laminated single cell about these return plates 90 and 95 is shown in drawing 12. Drawing 12 (A) expresses the return plate 90, and drawing 12 (B) expresses the return plate 95.

[0083]The oxidizing gas supplied from the oxidizing gas feed unit formed in the fuel cell exterior is introduced in the stack structure 115 via the pore 75 provided in the return plate 90. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 55 of the separator 30, passing through the inside of the oxidizing gas supply manifold 60 formed of the pore 40 of the separator 30. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 63 formed of the pore 43, flows in the same direction as the oxidizing gas supply manifold 60, and reaches the return plate 95.

[0084]The crevice 171 which connects to the return plate 95 the end of the above-mentioned oxidizing gas exhaust manifold 63 and the end of the oxidizing gas supply manifold 61 formed of the pore 44 is formed, and oxidizing gas is introduced into the oxidizing gas supply manifold 61. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 56 of each separator 30, passing through the inside of the oxidizing gas supply manifold 61 toward the return plate 90 side. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 64 formed of the pore 41, flows in the same direction as the oxidizing gas supply manifold 61, and reaches the return plate 90.

[0085]The crevice 72 which connects to the return plate 90 the end of the above-mentioned oxidizing gas exhaust manifold 64 and the end of the oxidizing gas supply manifold 62 formed of the pore 42 is formed, and oxidizing gas is introduced into the oxidizing gas supply manifold 62. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 57 of each separator 30, passing through the inside of the oxidizing gas supply manifold 62 toward the return plate 95 side. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 65 formed of the pore 45, flows in the same direction as the oxidizing gas supply manifold 62, and reaches the return plate 95. In the return plate 95, the pore 176 linked to the external oxidizing gas exhaust is formed in the position corresponding to the pore 45 of the separator 30, and oxidizing gas is discharged via this pore 176.

[0086]Thus, in an oxidizing gas supply manifold and the oxidizing gas exhaust manifold corresponding to this, even if it constitutes so that the flow direction of gas may become the same, the same effect as the 1st example can be acquired. Although the direction which flows into a lower part from the upper part, and the direction which flows upwards from a lower part considered the flow direction of oxidizing gas [in / at the example mentioned already / the gas passageway in a single cell] as the composition which interchanges by turns, its composition which always flows into a lower part from the upper part is also preferred. It is shown below by making such composition into the 2nd example.

[0087]The fuel cell of the 2nd example is constituted using the separator 30 like the example mentioned already, and the return plate 170 is allocated by the end of stack structure. In this stack structure, the

direction of [at the time of oxidizing gas passing] turns into for reverse like the stack structure 15 of the 1st example by the oxidizing gas supply manifold and the oxidizing gas exhaust manifold corresponding to this. Drawing 13 is an explanatory view showing the appearance of the return plate 170 seen from the field which touches the laminated single cell. Here, the same number was given to the member which is common in the return plate 70 of the 1st example.

[0088]The fuel cell of the 2nd example receives supply of oxidizing gas from an oxidizing gas feed unit via the pore 75 of the return plate 170 like the 1st example. This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part 55 from the oxidizing gas supply manifold formed of the pore 40 of the separator 30, It joins by the oxidizing gas exhaust manifold formed of the pore 43 of the separator 30, and returns to the return plate 170. The crevice 271 which connects the pore 43 and the pore 41 of the separator 30 is established in the return plate 170, and oxidizing gas is introduced into the oxidizing gas supply manifold formed of the pore 41 of the separator 30.

[0089]This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part 56, joins by the oxidizing gas exhaust manifold formed of the pore 44 of the separator 30, and returns from the oxidizing gas supply manifold formed of the pore 41 to the return plate 170. The crevice 272 which connects the pore 44 and the pore 42 of the separator 30 is established in the return plate 170, and oxidizing gas is introduced into the oxidizing gas supply manifold formed of the pore 42 of the separator 30.

[0090]This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part 57, joins by the oxidizing gas exhaust manifold formed of the pore 45 of the separator 30, and returns from the oxidizing gas supply manifold formed of the pore 42 to the return plate 170. The pore 76 is formed in the return plate 170 at the position corresponding to the pore 45, and oxidizing gas is discharged by the external oxidizing gas exhaust via this pore 76.

[0091]Thus, the manifold formed of the pores 40, 41, and 42 formed in the upper part in the separator 30 allocated by the inside in the fuel cell of the 2nd example, It is a manifold of the side which supplies oxidizing gas to the oxidizing gas passage in a single cell, and the manifold formed of the pores 43, 44, and 45 formed in the bottom is a near manifold with which oxidizing gas is discharged from the oxidizing gas passage in a single cell. Therefore, in the oxidizing gas passage in a single cell formed of the rib parts 55, 56, and 57, it always goes caudad from the upper part, and oxidizing gas flows.

[0092]According to the fuel cell of the 2nd example constituted as mentioned above, since oxidizing gas always flows into a lower part from the upper part in the oxidizing gas passage in a single cell, the effect that the wastewater nature in the oxidizing gas passage in a single cell can be raised is done so. As mentioned already, when electrochemical reaction advances with a fuel cell, produced water arises very in a such side, the produced produced water is evaporated in oxidizing gas, and it is discharged outside, but such produced water may condense in the oxidizing gas passage in a single cell. When the condensed produced water accomplishes waterdrop and stagnates in a channel, there is a possibility of blockading the oxidizing gas passage in a single cell, and barring circulation of gas, but. By always carrying out caudad the flow direction of the gas in the oxidizing gas passage in a single cell from the upper part, the water of condensation becomes that it is easy to be discharged according to gravity, and it can prevent producing the inconvenience stagnated and described above in the channel.

[0093]In the position of stack structure, for example, a return plate etc., it is good also as providing the drain port for discharging the condensed produced water outside. It can prevent discharging the produced water which was not discharged in the state where it evaporated in oxidizing gas by this out of a fuel cell, and barring the flow of oxidizing gas with the condensed produced water.

[0094]Although the gas supply manifold and gas exhaust manifold which are formed of the pore with which a separator is provided were penetrated and formed from the one end to the other end along the laminating direction of stack structure in the example mentioned already, In such a manifold, it is good also as providing a blocking section on the way and changing the flow direction of the gas in the gas passageway in a single cell. Such composition is explained below as the 3rd example.

[0095]Drawing 14 is an explanatory view which expresses superficially the flow of the oxidizing gas within the stack structure 315 which constitutes the fuel cell of the 3rd example. Since it has the stack

structure 115 mentioned already and the almost same structure, the stack structure 315 which constitutes the fuel cell of the 3rd example attaches the same number about a common member, and omits detailed explanation. Although the stack structure 315 of the 3rd example is constituted by laminating the separator 30 like the example mentioned already, unlike the example mentioned already, in the oxidizing gas supply manifold and the oxidizing gas exhaust manifold, the blocking section is provided in the middle. That is, in the predetermined separator 30 which constitutes the stack structure 315, the pore predetermined [of the pores 40-45] is blockaded, and it has the composition that the flow of the gas which passes through the inside of a manifold by this is intercepted.
[0096]As shown in drawing 14, the pores 40-45 with which the separator 30 is provided form the manifolds 360, 363, and 361,364,362,365 in the stack structure 315, respectively. As described above, in the predetermined separator 30 which constitutes the stack structure 315, the blocking section 96 is formed in the manifolds 360, 363, and 361,364,362,365 by blockading the predetermined pore, respectively.
[0097]Since the manifold 360 is connected to the external oxidizing gas feed unit via the return plate 90, rather than the blocking section 96 in the return plate 90 side. The manifold 360 works as an oxidizing gas supply manifold, and the manifold 363 works as an oxidizing gas exhaust manifold. In the manifolds of the downstream and these manifolds, and the oxidizing gas passage in a single cell open for free passage, interception of the flow of the gas which passes through the inside of the manifold 360 by the blocking section 96 will change the flow direction of gas rather than this blocking section 96. Namely, the manifold 360 works as an oxidizing gas exhaust manifold, The flow direction of the gas in the oxidizing gas passage in a single cell which the manifold 363 works as an oxidizing gas supply manifold, and is formed of the rib part 55, It becomes the flow direction of the oxidizing gas in the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in the single cell allocated in the upstream rather than the blocking section 96 for reverse.
[0098]The blocking section 96 is formed also like the manifold 363, and the flow direction of gas changes in the manifolds of the downstream and these manifolds, and the oxidizing gas passage in a single cell open for free passage rather than the blocking section 96 provided in this manifold 363. Namely, the manifold 360 turns into an oxidizing gas supply manifold, The flow direction of the gas in the oxidizing gas passage in a single cell which the manifold 363 turns into an oxidizing gas exhaust manifold, and is formed of the rib part 55, It returns to the flow direction and the same direction of gas in the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in the single cell allocated in the field contiguous to the return plate 90.
[0099]The blocking section 96 provided in each of the manifold 361,364,362,365 works similarly. Namely, when the flow of the oxidizing gas which passes through the inside of the manifold which works as an oxidizing gas supply manifold is intercepted by the blocking section 96, rather than this blocking section 96 in the downstream. The flow direction of the oxidizing gas in the oxidizing gas passage in a single cell which an oxidizing gas supply manifold and an oxidizing gas exhaust manifold interchange, and a corresponding rib part forms serves as for reverse.
[0100]According to the fuel cell of the 3rd example constituted as mentioned above, in addition to the effect to which the gas mass flow in a channel can be made to increase, the following effects can be done so by dividing the gas passageway in a single cell in the same field like the example mentioned already. That is, by providing a blocking section in the manifold which works as a gas supply manifold, the gas mass flow which passes each gas passageway in a single cell can be made to be able to increase further, and the capacity factor of gas can be raised. For example, when supplying oxidizing gas to the manifold which the pore 40 with which the separator 30 is provided forms, in this example. Although oxidizing gas is distributed to the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in each of the single cell allocated in before the position in which the blocking section was provided from the end to which oxidizing gas is supplied, In the fuel cell which does not provide a blocking section in a manifold, oxidizing gas will be distributed to the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in each of all the single cells which constitute stack structure. Therefore, even if the gas volume supplied from the outside by providing a blocking section in

a manifold is constant, the gas volume which passes the gas passageway in a single cell can be increased further, and the above-mentioned effect can be acquired.

[0101]Although the flow of the gas which passes the gas passageway in a single cell also by connecting in series the stack structure which divided into plurality the stack structure which constitutes a fuel cell, and was divided can be made to increase as mentioned already, In the fuel cell of the 3rd example, by easy composition of providing a blocking section in a gas manifold (the predetermined pore is closed in the predetermined separator). In order to be able to make the flow of the gas which passes the gas passageway in a single cell increase and to make a gas mass flow increase, it is not necessary to complicate piping of gas. In such a fuel cell, the grade to which the gas volume which passes each gas passageway in a single cell is made to increase can be adjusted by adjusting the position and number of blocking sections which are formed in a gas manifold. Like this example, if a blocking section is provided in the middle of a manifold, the passage resistance in the gas passageway formed in stack structure will increase. Therefore, passage resistance can be freely set up by the whole stack structure by adjusting the position which provides the number of blocking sections, and a blocking section. Although the above-mentioned example showed the composition which provides a blocking section in the manifold which oxidizing gas passes, it is good also as providing the same blocking section in the manifold which fuel gas passes.

[0102]It can also have different composition, although the gas passageway in a single cell was formed so that the manifold formed in the position which counters might be made to open for free passage, and the gas which passes through the inside of the gas passageway in a single cell was considered as the composition which flows into a certain direction in the example mentioned already. Below, the fuel cell of such composition is shown as the 4th example. Drawing 15 is a top view showing the composition of the separator 430 which constitutes the fuel cell of the 4th example, and drawing 16 is a top view showing the composition of the return plate 470 with which the fuel cell of the 4th example is provided. The stack structure which constitutes the fuel cell of the 4th example, Since it has the almost same composition as the stack structure 15 of the 1st example except replacing with the separator 30, having the separator 430, replacing with the return plate 70, and having the return plate 470, the detailed explanation about common composition is omitted.

[0103]The separator 430 equips the periphery with the pores 440-443,450-453. Here, the pores 440-443 adjoin one by one, along with one predetermined side of the separator 430, there are and they are provided, and the pores 440-443 adjoin the neighborhood provided in the neighborhood one by one along with the neighborhood which counters, and there are the pores 450-453 and they are provided. The crevice 455 and the crevice 456 are formed on one field of the separator 430. The crevice 455 and the crevice 456 are mutually formed in U type sideways [parallel], respectively. The crevice 455 is open for free passage with the pore 450 and the pore 451 in the both ends, respectively. The crevice 456 is open for free passage with the pore 452 and the pore 453 in the both ends, respectively. In the crevice 455,456, in the separator 430, the crevice 455,456 and two same crevices are formed in U type for reverse in the field of the opposite hand with the field shown in drawing 15 (not shown). One side of two crevices formed in this rear face is open for free passage with each of the pore 440 and the pore 441 in both ends, and the crevice of another side is open for free passage with each of the pores 442 and 443 in both ends.

[0104]In the fuel cell constituted using such a separator 430, the crevice 455 and the crevice 456 form the fuel gas flow route in a single cell between the adjoining anodes 32, and two crevices formed in the rear face mentioned above form the oxidizing gas passage in a single cell between the adjoining cathodes 33. Within the stack structure as for which the pore 450 and the pore 452 laminate and form the separator 430, Forming the fuel gas supply manifold which distributes fuel gas to the fuel gas flow route in a single cell, the pore 451 and the pore 453 form the fuel gas exhaust manifold in which the fuel gas discharged from the fuel gas flow route in a single cell similarly gathers within stack structure. Similarly, within stack structure, the pore 440 and the pore 442 form in the oxidizing gas passage in a single cell the oxidizing gas supply manifold which distributes oxidizing gas, and the pore 441 and the pore 443, Similarly the oxidizing gas discharged from the oxidizing gas passage in a single cell forms

the oxidizing gas exhaust manifold which gather within stack structure.
[0105]The pore 457 and the pore 458 are formed in the periphery of the separator 430 near the pore 450 and the pore 453, respectively. These pores 457,458 form the cooling water manifold mentioned already within the stack structure which laminates and forms the separator 430. The cooling water supplied from the outside of a fuel cell via the cooling water manifold formed of the pore 457, The cooling water which is distributed to the cooling channel between single cells mentioned already, and is discharged from each cooling channel between single cells is led to the fuel cell exterior via the cooling water manifold formed of the pore 458.
[0106]Although it expressed with drawing 15 that the crevice with which the separator 430 is provided has a flat concave surface, Two or more heights of the predetermined shape projected and provided from the concave surface are provided in each crevice with which the actual separator 430 is provided like the uneven part with which the separator 30A shown in drawing 5 is provided. The gas which passes the gas passageway in a single cell formed of a crevice by such heights is stirred, and when the gas diffusion electrode and heights which adjoin the separator 430 touch, conductivity sufficient between gas diffusion electrodes is secured.
[0107]The return plate 470 is provided with the pores 475-478, the pore 491,492, and the crevice 471,474. This return plate 470 is allocated by the end of stack structure like the return plate 70 in the stack structure 15 of the 1st example that showed drawing 7 and drawing 8 the top view of the situation of the flow of gas. When forming stack structure using the return plate 470, the return plate 470 is allocated so that the field expressed to drawing 16 may touch the structure which laminated the single cell. The pores 475-478, the pore 491,492, and the crevice 471,474 with which this return plate 470 is provided in drawing 16, physical relationship (it can set to the stack structure which laminated and assembled the member containing the return plate 470 and the separator 430.) with the pores 440-443,450-453,457,457 and the crevice 455,456 with which the separator 430 is provided The dotted line showed the position of the above-mentioned pore with which the separator 430 is provided, and the crevice on the return plate 470 so that the physical relationship of the above-mentioned pore and a crevice might be known.
[0108]The pore [in / on the formed stack structure and / in the pore 477 / the separator 430] 450, The pore [in / in the pore 453 in the separator 430 with which the pore 478 adjoins, and the pore 475 / the separator 430] 440, The pore 457 in the separator 430 and the pore 492 correspond respectively in position with the pore 458 in the separator 430, and the pore 476 opens mutually the pore 443 in the separator 430, and the pore 491 for free passage. The crevice 474 covers the field in which the pore 451,452 is formed in the separator 430, and is formed, and the gas manifold which the pore 451,452 forms within stack structure is made to open for free passage mutually in the end of stack structure. Similarly, the crevice 471 covers the field in which the pore 441,442 is formed in the separator 430, and is formed, and the gas manifold which the pore 441,442 forms within stack structure is made to open for free passage mutually in the end of stack structure.
[0109]The situation of the flow of the gas in the fuel cell which equips below with the separator 430 and the return plate 470 is explained. As for the stack structure which constitutes the fuel cell of this example, in each of both ends, the collecting electrode plate, the electric insulating plate, and the end plate are allocated like the stack structure 15 shown in drawing 3. To these collecting electrode plates, an electric insulating plate, and an end plate. The pore is provided in the position corresponding to the pore with which the separator 430 is provided, and it becomes possible like the example mentioned already by connecting the pore of such an end plate, and an external device to carry out the feeding and discarding of the fluid to a fuel cell. The pore 477 with which the return plate 470 is provided is connected with a fuel gas feed unit via the pore (pore provided in the position corresponding to the position in which the pore 477 was formed) provided in the collecting electrode plate, electric insulating plate, and end plate which adjoin this return plate 470 and are allocated. On the other hand (channel which the crevice 455 forms), the fuel gas flow route in a single cell formed in each single cell is distributed via the fuel gas supply manifold which the pore 450 which the separator 430 equips with the supplied fuel gas forms. The fuel gas which passed the fuel gas flow route in this single cell gathers to

the fuel gas exhaust manifold which the pore 451 forms, and is led to the fuel gas supply manifold which the pore 452 forms by the crevice 474 with which the return plate 470 is provided. The fuel gas which fuel gas was distributed to another [which was further formed in each single cell from this fuel gas supply manifold] fuel gas flow route in a single cell (channel which the crevice 456 forms), and passed the fuel gas flow route in this single cell gathers to the fuel gas exhaust manifold which the pore 453 forms. The pore is provided in the position corresponding to the position in which the pore 478 with which the return plate 470 equips the above-mentioned collecting electrode plate, an electric insulating plate, and an end plate was formed, and the fuel gas which gathered to the above-mentioned fuel gas exhaust manifold is discharged by the external fuel gas exhaust via these pores.
[0110]It is constituted similarly, and oxidizing gas is supplied from the exterior to the oxidizing gas supply manifold which the pore 440 with which the separator 430 is provided forms, and the channel of oxidizing gas is also distributed to one side of the oxidizing gas passage in a single cell formed in each single cell. The oxidizing gas which passed through the oxidizing gas passage in these single cells gathers to the oxidizing gas exhaust manifold which the pore 441 forms, and is led to the oxidizing gas supply manifold which the pore 442 forms by the crevice 471 established in the return plate 470. The oxidizing gas further distributed to another side of the oxidizing gas passage in a single cell formed in each single cell from this oxidizing gas supply manifold gathers to the oxidizing gas exhaust manifold which the pore 443 forms, and is drawn outside.
[0111]The pore is provided also in the position corresponding to the pore 491,492 with which the return plate 470 equips a collecting electrode plate, an electric insulating plate, and an end plate, respectively. Among these, a predetermined cooling water feed unit is connected to the pore corresponding to the pore 491, cooling water is supplied to the cooling water manifold which the pore 457 with which the separator 430 is provided forms, and the supplied cooling water is distributed to the circulating-water-flow way between single cells mentioned already from this cooling water manifold. The cooling water which passed through the circulating-water-flow way between single cells gathers to the cooling water manifold which the pore 458 forms, and is discharged by the predetermined cooling-water-discharge device via the pore corresponding to the above-mentioned pore 492.
[0112]By according to the fuel cell of such 4th example, dividing the gas passageway in a single cell into plurality on the same field, and making small the cross-section area of the gas passageway in a single cell, The flow and the rate of flow of gas in the channel in a single cell are raised, and, in addition to the same effect as the example mentioned already of raising the capacity factor of the gas in a fuel cell, the still more nearly following effects are done so. That is, by forming in U type each of the gas passageway in a single cell divided into plurality on the same side, the rate of the area of the field (it is hereafter called a collecting section) which contributes to electrochemical reaction among the whole cross-section area of stack structure can be made high, and the whole fuel cell can be miniaturized.
[0113]In a fuel cell provided with the divided gas passageway in a single cell which was formed in linear shape like the 1st example, Also when the whole collecting section is quadrisected in parallel, and also when it constitutes a fuel cell using the separator 430 which forms the gas passageway in a single cell of U type like this example, Although the effect which becomes small is acquired similarly and a passage sectional area both needs to provide four pores (in order to form a manifold) along with one predetermined side of a separator, It is not necessary to provide a pore in the field which met the neighborhood which counters the one above-mentioned side, and this field can be used as the above-mentioned collecting section in the fuel cell of this example. If it puts in another way, one field (field near the neighborhood which counters the one above-mentioned side) of the fields in which a pore is formed in the separator which forms the gas passageway in a single cell of the divided linear shape will become unnecessary. When a part of pore which forms a manifold becomes unnecessary, the seal structure (structure for maintaining the airtightness in a manifold) established around a pore also becomes unnecessary, and can simplify the structure of a separator and a seal. Therefore, the cross-section area of small size, i.e., a fuel cell, can be made smaller more for a fuel cell. By this, members forming, such as a separator, can be made smaller and the material cost can be reduced. In carrying in an electromobile by using this fuel cell as the power supply for vehicles by the ability to miniaturize a fuel

cell, the flexibility of a vehicle design improves.
[0114]By the fuel gas and oxidizing gas side, especially the gas passageway in a single cell divided in the fuel cell of this example is formed so that it may become U type of the direction which counters mutually. If the pore which will form the manifold which carries out the feeding and discarding of one gas along with one predetermined side in a separator if it has such composition is provided, The pore which forms the manifold which carries out the feeding and discarding of the gas of another side is formed along with the one above-mentioned side and the neighborhood which counters, and does not need to provide the pore for forming a manifold near [remaining] the two sides. Therefore, a predetermined direction can be shortened in the shape of a fuel cell. A fuel cell can be made into shape short to a lengthwise direction when forming in sideways U type the crevice which forms the gas passageway in a single cell like the separator 430 shown in drawing 15. Thus, if a fuel cell is made into shape short to a lengthwise direction, when it carries in an electromobile by using a fuel cell as the power supply for vehicles, in allocating a fuel cell under a seat, it becomes advantageous especially.
[0115]In the separator which constitutes such a fuel cell, as mentioned already, the manifold which carries out the feeding and discarding of the cooling water other than the manifold which carries out the feeding and discarding of the gas is also formed, but. Since the manifold of cooling water can be formed in the position which is separated from a collecting section rather than the manifold of gas, the above-mentioned effect that the lengthwise direction of a fuel cell can be made small is not spoiled by forming the manifold of cooling water. Namely, in order to supply the gas which contributes to electrochemical reaction directly to each single cell at sufficient efficiency. Although providing in the field near a collecting section is desirable as for the manifold of gas, the manifold of the cooling water which is not directly contributed to electrochemical reaction, Since it does not interfere even if it provides in the more distant field from a collecting section, when forming a cooling water manifold, what is necessary is just to provide in the distance from a collecting section, and it is not necessary to enlarge the lengthwise direction of a fuel cell rather than a gas manifold. If shape of the section of a collecting section is made elliptical [on which the angle was dropped] like the fuel cell constituted using the separator 430 especially shown in drawing 15, the breadth to the transverse direction of a fuel cell can also be stopped. Namely, since an excessive space will produce near the corner if the shape of the section of stack structure is a quadrangle if a gas manifold is provided along with an elliptical collecting section, Maintaining the shortness of the lengthwise direction of a fuel cell by forming a cooling water manifold using this space, it stops that a fuel cell becomes large in a transverse direction, and the whole fuel cell can be miniaturized. In making shape of the whole collecting section into the quadrangle instead of an ellipse form and forming a gas passageway in U type, the flow of gas becomes insufficient easily and the corner which hits the pars basilaris ossis occipitalis of this U character has a possibility that electrochemical reaction may not fully advance. Therefore, as described above, even if it reduces the area of the collecting section which is equivalent to a corner by using a collecting section as an ellipse form, it is so much uninfluential to battery capacity.
[0116]In the separator 430 to constitute, the fuel cell of this example the downstream field (linear area of the direction near the pore 451) of the crevice 455, Compared with the upstream field (linear area of the direction near the pore 450), width is formed narrowly, and, similarly, as for the downstream field (linear area of the direction near the pore 453) of the crevice 456, width is narrowly formed compared with the upstream field (linear area of the direction near the pore 452) (refer to drawing 15). In the lower stream, in the gas passageway in a single cell of a fuel cell provided with such a separator 430, a passage sectional area becomes small. Within a fuel cell, the electrode active material concentration in a gas mass flow and gas decreases in connection with the electrode active material in the supplied gas being consumed by electrochemical reaction. Therefore, by making a passage sectional area small in this way as the lower stream, it can compensate with a gas mass flow decreasing, a uniform reaction can be expected with the whole fuel cell, and sufficient voltage can be secured.
[0117]Since the gas passageway in a single cell is formed in U type, the fuel cell of this example does so the effect that the rate of gas utilization can be raised further, compared with the case where the gas passageway in a single cell is formed in linear shape. That is, when gas is led to the shape of a channel

and the flow direction changes for reverse, it becomes easy to generate a turbulent flow in the field which hits the pars basilaris ossis occipitalis of U type, and the capacity factor of gas improves by stirring gas more.

[0118]In the fuel cell of this example, it writes with the composition which makes shape of the gas passageway in a single cell sideways U type, goes caudad from the upper part, and passes gas by both by the side of fuel gas and oxidizing gas, and the effect that the draining mechanism of the produced water produced within a gas passageway can be simplified is done so. For example, when the oxidizing gas passage in a single cell is provided in the perpendicular direction like the 1st example, the produced produced water is led to the oxidizing gas passage in a single cell, falls caudad, and collects on each of three downward manifolds (the oxidizing gas exhaust manifolds 63 and 65, oxidizing gas supply manifold 61). In such a fuel cell, the sewer valve needed to be provided in these manifolds, respectively, and produced water needed to be removed. In the fuel cell of this example, since each gas passageway in a single cell serves as sideways U type, the produced produced water is led to the pressure and gravity into which gas flows, and is gradually led to the downstream in the gas passageway in a single cell. Thus, since it is eventually led to the manifold which the pore 453 or the pore 443 with which the separator 430 is provided forms, if a draining mechanism is provided only in the manifold located in the method of these bottom, it is sufficient for produced water. Or composition can be simplified further, without providing a draining mechanism in the inside of a fuel cell with the pressure of gas, if the discharge to the exterior of a fuel cell is possible for the produced water led to these manifolds enough.

[0119]Although the crevice of U type for forming the gas passageway in a single cell was established in each two field of every in the separator 430 which constitutes the fuel cell of this example, the number of partitions (the number of the crevices formed on the same side) of the gas passageway in a single cell is good also as two or more. What is necessary is just to determine the number of partitions suitably in consideration of the grade etc. whose energy required in order to pressurize gas, when supplying gas increases, when it increases the number of partitions and passage resistance increases, the effect by a passage cross section becoming small and the rate of flow of gas becoming early by increasing the number of partitions, and. In the separator 430, the adjacent spaces which form a manifold, and the field which forms a collecting section may be formed by one, or may be formed by a different body.

[0120]In the fuel cell of this example, and the fuel cell of the 1st example, the gas which passed the gas exhaust manifold is introduced in a return plate in the gas supply manifold adjoined and provided in this gas exhaust manifold. Therefore, in order to draw gas, the crevice established in a return plate is small, and ends (it being short), and the capacity of a crevice can be stopped. While gas passes through the inside of this crevice, it does not contribute to power generation, but when the size and the amount of distributed gas of a fuel cell are set constant, generation efficiency can fully be secured by stopping the gas volume which does not contribute to a reaction.

[0121]As described above, when being led to the gas manifold which the gas which passed the predetermined gas manifold adjoins by the crevice with which a return plate is provided, the gas sealing structure near the crevice of this return plate can be simplified. That is, the case where different gas (oxygen and hydrogen) adjoins near the field where the entrance of gas of the same kind adjoins does not need to secure airtightness more strictly.

[0122]Although the gas which divides the channel of gas in parallel with the laminating direction of stack structure, and is supplied in single stack structure at stack structure was considered as the composition which passes through the inside of these divided channels one by one in the example mentioned already, It is good also as connecting two or more such stack structures, constituting a fuel cell, and securing more electric power. The composition of the fuel cell which consists of two or more stack structures is explained below as the 5th example. Drawing 17 is an explanatory view showing the composition of the fuel cell 500 of the 5th example provided with four stack structures, and drawing 18 is a top view showing the composition of the separator 530 with which each stack structure with which the fuel cell 500 is provided was equipped. The fuel cell 500 was provided with the four stack structures 515A, 515B, 515C, and 515D, connected such stack structures mutually with the feeding-and-discarding box 512, and has stored such structures in the case 510. Although the case 510 has covered the four

whole stack structure, drawing 17 removes one side of the field big No. 1 in the case 510, and it expresses signs that the inside of the case 510 was seen from this removed field side. Since each stack structure with which the fuel cell 500 is provided has the composition which is common in the example mentioned already except how to flow through the structure of the separator with which this is provided, and the gas in an inside, the detailed explanation about each stack structure is omitted.

[0123]The feeding-and-discarding box 512 is the box-like member allocated in the center section of the fuel cell 500, and is formed by the material which has predetermined rigidity, for example, aluminum etc.It faces across this feeding-and-discarding box 512, the stack structures 515A and 515B are allocated in one side, and the stack structures 515C and 515D are allocated in another side. This feeding-and-discarding box 512 is connected with the fuel gas feed unit, the fuel gas exhaust, the oxidizing gas feed unit, and the oxidizing gas exhaust which were provided outside. The channel of predetermined shape is formed in the inside of the feeding-and-discarding box 512, and distribute the fuel gas and oxidizing gas which were supplied by this channel from the outside to each stack structure with which the fuel cell 500 is provided, and. The gas which draws outside the gas discharged by passing through the inside of stack structure, and is exchanged between each stack structure is drawn.

[0124]In those both ends, the application-of-pressure maintaining structure 514 is established, to each stack structure, thrust is applied to the fuel cell 500 toward the feeding-and-discarding box 512 side from the end side, and each stack structure is held within the case 510 according to this application-of-pressure maintaining structure 514 to it. the application-of-pressure maintaining structure 514 of this example is provided with the pressurizing shafts 501, and these pressurizing shafts 501 are thrust into a predetermined hole structure (not shown) provided in the end of the case 510 -- this hole -- the welding pressure to each stack structure is held by screwing in structure. The pressure plate 502 is formed in the end (end side of the case 510) of each stack structure. The thrust applied from the pressurizing shafts 501 is told to stack structure via this pressure plate 502, and the whole stack structure in a case is pressurized (refer to drawing 17).

[0125]As shown in drawing 18, the pores 540-545 and the pores 550-555 are formed in the separator 530, and on one field, The crevice 548 which makes the crevice 547 which makes the crevice 546 which makes the pores 540 and 543 open for free passage, and the pores 541 and 544 open for free passage, and the pores 542 and 545 open for free passage is formed (refer to drawing 18 (A)). On another field, the crevice 558 which makes the crevice 557 which makes the crevice 556 which makes the pores 550 and 553 open for free passage, and the pores 551 and 554 open for free passage, and the pores 552 and 555 open for free passage is formed (refer to drawing 18 (B)). The pores 540-545 form respectively the acid gas manifolds 560-565 which carry out the feeding and discarding of the oxidizing gas within stack structure, and the pores 550-555 form respectively the fuel gas manifolds 580-585 which carry out the feeding and discarding of the fuel gas (refer to drawing 18). The crevices 546-548 form the oxidizing gas passage in a single cell within stack structure, and the crevices 556-558 form the fuel gas flow route in a single cell. Although the statement was omitted in drawing 18, The crevices 546-548,556-558 with which the separator 530 is provided are provided with the heights of predetermined shape which secure conductivity between the gas diffusion electrodes which the gas which passes the gas passageway in a single cell as well as the separator 430 mentioned already is stirred, and adjoin.

[0126]The fuel cell 500 equips with one return plate in connection with the channel of fuel gas at a time the end (end of the side in which the application-of-pressure maintaining structure 514 is formed) of each stack structure. the end of the stack structure 515A -- the return plate 590A -- the return plate 590C is allocated by the end of the stack structure 515C, and the return plate 590D is allocated in the end of the stack structure 515D for the return plate 590B by the end of the stack structure 515B. Drawing 19 thru/or drawing 22 are the top views showing the composition of these return plates, and expresses signs that all were seen from the side which touches the laminated single cell 20 (going to the pressure plate 502 side from the feeding-and-discarding box 512 side). the return plate 590A -- the crevice 571 and the crevice 591 -- the return plate 590B -- as for the return plate 590C, the return plate 590D equips [the crevice 572 and the crevice 592] the surface with the crevice 579 and the crevice 594 for the crevice 574 and the crevice 593. The crevice 571,572,574,579 is a structure which forms the channel of fuel gas

here, and the crevice 591 - the crevice 594 are structures which form the channel of oxidizing gas.
[0127]Express the superficial composition of the return plates 590A-590D with drawing 19 thru/or drawing 22, and. The situation of the flow of the gas within the fuel cell 500 is explained, and also [expedient] physical relationship with a part of pore with which the separator 530 laminated in the same stack structure is provided and which was mentioned already, and the above-mentioned crevice with which each return plate is provided was also shown collectively. Here, the pore of the separator 530 located within each stack structure corresponding to each crevice with which each return plate is provided was expressed with the dotted line on each return plate in each of drawing 19 thru/or drawing 22. Namely, the crevice 571 with which the return plate 590A is provided in the stack structure 515A, The fuel gas manifold 581,582 which the pore 551,552 with which the separator 530 is provided forms is made to open for free passage, and the crevice 591 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 19). Similarly in the stack structure 515B, the crevice 572 with which the return plate 590B is provided, The fuel gas manifold 581,582 which the pore 551,552 with which the separator 530 is provided forms is made to open for free passage, and the crevice 592 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 20). The crevice 574 with which the return plate 590C is provided in the stack structure 515C, The fuel gas manifold 580,581 which the pore 550,551 with which the separator 530 is provided forms is made to open for free passage, and the crevice 593 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 21). Similarly by the stack structure 515D, the crevice 579 with which the return plate 590D is provided, The fuel gas manifold 580,581 which the pore 550,551 with which the separator 530 is provided forms is made to open for free passage, and the crevice 594 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 22). The situation of direction of lamination of each member in the fuel cell 500 and the flow of gas is explained in detail later.
[0128]The direction of lamination of the single cell 20 is the same as the stack structures 515A and 515C among four stack structures with which the fuel cell 500 is provided, and, in the laminating direction of the stack structures 515B and 515D, these serve as for reverse. The stack structures 515A-515D which constitute the fuel cell 500 equip each both ends with the same collecting electrode plate as the example mentioned already. Namely, in the both ends of the stack structure 515A the collecting electrode plates 536A and 537A, The collecting electrode plates 536C and 537C are allocated in the both ends of the stack structure 515C, and the collecting electrode plates 536D and 537D are allocated in the both ends of the stack structure 515B for the collecting electrode plates 536B and 537B by the both ends of the stack structure 515D, respectively (refer to drawing 17). These collecting electrode plates are provided with the terminal for taking out electric power from each stack structure like [although the statement was omitted in drawing 17] the example mentioned already. The situation of connection of the terminal provided in the collecting electrode plate with which each stack structures 515A-515D equip below is explained.
[0129]The terminal of the collecting electrode plate 537A formed in feeding-and-discarding box 512 side edge part in the stack structure 515A is connected with the terminal of the collecting electrode plate 536C formed in feeding-and-discarding box 512 side edge part in the stack structure 515C which confronts each other across the feeding-and-discarding box 512. The terminal of the collecting electrode plate 537C formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515C is connected with the terminal of the collecting electrode plate 536D formed in application-of-pressure maintaining structure 514 side edge part in the adjacent stack structure 515D. The terminal of the collecting electrode plate 537D formed in feeding-and-discarding box 512 side edge part in the stack structure 515D is connected with the terminal of the collecting electrode plate 536B formed in feeding-and-discarding box 512 side edge part in the stack structure 515B which confronts each other across the feeding-and-discarding box 512.
[0130]Since the direction of lamination of the single cell 20 is for reverse here by the stack structures

515A and 515C and the stack structures 515B and 515D as mentioned already, By connecting the contact button of each stack structure end as mentioned above, the stack structures 515A-515D are connected in series in order of the stack structures 515A, 515C, 515D, and 515B. If the stack structures 515A-515D are connected in series as mentioned above, The terminal of the collecting electrode plate 536A formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515A, The terminal of the collecting electrode plate 537B formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515B turns into an output terminal of the fuel cell 500, and electric power can be taken out from these terminals.

[0131]Below, the situation of the flow of the fuel gas in such a fuel cell 500 is explained. Drawing 23 thru/or drawing 25 are the explanatory views showing the situation of the flow of the fuel gas in the fuel cell 500. By drawing 23 thru/or drawing 25, the situation of the flow of the fuel gas of the fuel cell 500 whole was shown, and the situation of the flow of the fuel gas in the fuel gas flow route in a single cell formed in each stack structure was also collectively shown near each stack structure. As a situation of the flow of the fuel gas of the fuel cell 500 whole, the state where the fuel cell 500 was seen from the same direction as drawing 17 was shown. The situation of the flow of the fuel gas in the fuel gas flow route in a single cell was expressed based on signs that the separator 530 with which each stack structure is provided was seen toward the side in which the return plates 590C and 590D were allocated from the side in which the return plates 590A and 590B were allocated. If the separator 530 is seen from such a direction, the field in which the crevices 556-558 in connection with the flow of fuel gas are formed will serve as a side front (side shown by drawing 23 - drawing 25) in the stack structures 515B and 515D, but. In the stack structures 515A and 515C, it becomes the back side (side which is not shown by drawing 23 - drawing 25). Therefore, when the flow of the fuel gas in the single cell in the stack structures 515B and 515D was expressed with drawing 23 - drawing 25, the solid line expressed the crevices 556-558 by them, but. When the flow of the fuel gas in the single cell in the stack structures 515A and 515C was expressed, the crevices 556-558 were expressed with the dashed line. Here, such crevices 556-558 shown by drawing 23 - drawing 25 show only the thing in connection with the explanation in a figure with the above-mentioned solid line and the dashed line. In drawing 23 - drawing 25, the statement of the pore in connection with the flow of the oxidizing gas with which the separator 530 is provided for convenience since the situation of the flow of the fuel gas in the fuel gas flow route in a single cell is expressed, etc. is omitted.

[0132]The fuel gas supplied from the outside to the feeding-and-discarding box 512 is distributed to the stack structures 515A and 515B via the channel in the feeding-and-discarding box 512. At this time, the fuel gas supplied from the external fuel gas feed unit, without it is divided into two according to the shape of the channel formed in the feeding-and-discarding box 512 and changes the flow direction of gas -- the stack structures 515A and 515B -- it is each upper bed side and is led to the fuel gas manifold boiled and provided from the center of the fuel cell 500. That is, the fuel gas supplied from the outside is drawn in the fuel gas manifold 580 which the pore 550 provided in the separator 530 with which the stack structures 515A and 515B are provided forms (refer to drawing 23). As mentioned already, since the direction of lamination of the single cell 20 is different, the manifold with which fuel gas is introduced first turns into the fuel gas manifold 580 which the pore 550 forms also in which stack structure by the stack structures 515A and 515B. In the stack structures 515A and 515B, the fuel gas introduced into the fuel gas manifold 580 which the pore 550 forms is distributed to the fuel gas flow route in a single cell which the pore 550 and the crevice 556 open for free passage form, and gathers after that to the fuel gas manifold 583 which the pore 553 forms. That is, in the stack structures 515A and 515B, the fuel gas manifold 583 works as a fuel gas exhaust manifold.

[0133]In each of the stack structures 515A and 515B here, The fuel gas manifold 583 formed of the pore 553 and the fuel gas manifold 583 formed of the pore 553 in each of the stack structures 515C and 515D are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 583 formed of the pore 553 in the stack structures 515A and 515B, It is led to the stack structures 515C and 515D via the feeding-and-discarding box 512, and is led to the fuel gas manifold 583 formed of the pore 553. When making such connection, the gas exhaust manifold formed in the

stack structures 515A and 515B is connected to these and the gas manifold formed in the corresponding position in the stack structures 515C and 515D. Therefore, although the fuel gas manifold 580 turns into a fuel gas supply manifold and the fuel gas manifold 583 turns into a fuel gas exhaust manifold in the stack structures 515A and 515B, In the stack structures 515C and 515D, these become reverse, the fuel gas manifold 580 turns into a fuel gas exhaust manifold, and the fuel gas manifold 583 turns into a fuel gas supply manifold.
[0134]In the stack structures 515C and 515D, from the fuel gas manifold 583 which the pore 553 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 556 forms, and passed the fuel gas flow route in these single cells, It gathers to the fuel gas manifold 580 which the pore 550 forms, and results in the return plates 590C and 590D allocated by the end by the side of the application-of-pressure maintaining structure 514. Here the crevice 574,579 (drawing 21, 22 references) with which the return plates 590C and 590D are provided, respectively, It laps with the pores 550 and 551 with which the adjoining separator 530 is provided, and the fuel gas manifold 580 which the pore 550 forms, and the fuel gas manifold 581 which the pore 551 forms are made to open for free passage, as mentioned already. Therefore, the fuel gas which has passed the fuel gas manifold 580 is led to the fuel gas manifold 581 which the pore 551 within the same stack structure forms by the crevice 574,579 in each of the return plates 590C and 590D. (Refer to drawing 24).
[0135]The fuel gas which the fuel gas manifold 581 worked as a fuel gas supply manifold, and was led to the fuel gas manifold 581 in the stack structures 515C and 515D, After being distributed to the fuel gas flow route in a single cell which the crevice 557 forms and passing the fuel gas flow route in these single cells, it gathers to the fuel gas manifold 584 which the pore 554 forms. That is, in the stack structures 515C and 515D, the fuel gas manifold 584 works as a fuel gas exhaust manifold.
[0136]In each of the stack structures 515C and 515D here, The fuel gas manifold 584 formed of the pore 554 and the fuel gas manifold 584 formed of the pore 554 in each of the stack structures 515A and 515B are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 584 which is a fuel gas exhaust manifold in the stack structures 515C and 515D, In the stack structures 515A and 515B, it is led to the fuel gas manifold 584 formed of the pore 554 via the feeding-and-discarding box 512. That is, in the stack structures 515A and 515B, the fuel gas manifold 584 works as a fuel gas supply manifold (refer to drawing 24).
[0137]In the stack structures 515A and 515B, from the fuel gas manifold 584 which the pore 554 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 557 forms, and passed the fuel gas flow route in these single cells, It gathers to the fuel gas manifold 581 which the pore 551 forms, and results in the return plates 590A and 590B allocated by the end by the side of the application-of-pressure maintaining structure 514. That is, in the stack structures 515A and 515B, the fuel gas manifold 581 works as a fuel gas exhaust manifold.
[0138]Here the crevice 571,572 (drawing 19, 20 references) with which the return plates 590A and 590B are provided, respectively, It laps with the pore 551 and the pore 552 with which the adjoining separator 530 is provided, and the fuel gas manifold 581 which the pore 551 forms, and the fuel gas manifold 582 which the pore 552 forms are made to open for free passage, as mentioned already. Therefore, the fuel gas which has passed the fuel gas manifold 581 is led to the fuel gas manifold 582 which the pore 552 within the same stack structure forms by the crevice 571,572 in each of the return plates 590A and 590B. (Refer to drawing 25). The fuel gas which the fuel gas manifold 582 works as a fuel gas supply manifold, and passes the fuel gas manifold 582 in the stack structures 515A and 515B, After being distributed to the fuel gas flow route in a single cell which the crevice 558 forms and passing the fuel gas flow route in these single cells, it gathers to the fuel gas manifold 585 which the pore 555 forms. That is, in the stack structures 515A and 515B, the fuel gas manifold 585 works as a fuel gas exhaust manifold.
[0139]In each of the stack structures 515A and 515B here, The fuel gas manifold 585 formed of the pore 555 and the fuel gas manifold 585 formed of the pore 555 in each of the stack structures 515C and 515D are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 585 which is a fuel gas exhaust manifold in the stack structures 515A and 515B, In the stack

structures 515C and 515D, it is led to the fuel gas manifold 585 formed of the pore 555 via the feeding-and-discarding box 512. That is, in the stack structures 515C and 515D, the fuel gas manifold 585 works as a fuel gas supply manifold (refer to drawing 25).

[0140]In the stack structures 515C and 515D, from the fuel gas manifold 585 which the pore 555 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 558 forms, and passed the fuel gas flow route in these single cells gathers to the fuel gas manifold 582 which the pore 552 forms, and reaches the feeding-and-discarding box 512 again. That is, in the stack structures 515C and 515D, the fuel gas manifold 582 works as a fuel gas exhaust manifold. As mentioned already, the fuel gas which had connected the feeding-and-discarding box 512 with the fuel gas exhaust provided outside, and passed the fuel gas manifold 582 is discharged outside via the feeding-and-discarding box 512.

[0141]In the above, although the situation of the flow of the fuel gas in the fuel cell 500 was explained next, in advance of explanation of the situation of the flow of the oxidizing gas in the fuel cell 500, it is the channel of oxidizing gas provided in the feeding-and-discarding box 512, and the channel committed like the return plate mentioned already is explained. In the feeding-and-discarding box 512, the channel of this oxidizing gas is provided near the field which touches each stack structure. Drawing 26 is a mimetic diagram showing the section which cut the feeding-and-discarding box 512 in the E-E line shown in drawing 17, and drawing 27 is a mimetic diagram showing the section which cut the feeding-and-discarding box 512 in the F-F line shown in drawing 17. As shown in drawing 26 and 27, the channels 516-519 are established in the feeding-and-discarding box 512, and these channels are committed in each stack structure in order to make between predetermined oxidation gas manifolds open for free passage.

[0142]In addition to the channels 516-519, drawing 26 and 27 also showed collectively the position to which the pore (pore provided in the separator 530) which forms the oxidation gas manifold opened for free passage by these channels corresponds. Here, by drawing 26 and 27, the dashed line showed the position of the pore with which the separator 530 is provided. The channel 516 makes the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms open for free passage in the stack structure 515A, as shown in drawing 26. The channel 517 makes the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms open for free passage in the stack structure 515B. Similarly as shown in drawing 27, the channel 518, In the stack structure 515D, make it open for free passage, and the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms the channel 517, The oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms are made to open for free passage in the stack structure 515C.

[0143]Below, the situation of the flow of the oxidizing gas in such a fuel cell 500 is explained. Drawing 28 thru/or drawing 30 are the explanatory views showing the situation of the flow of the oxidizing gas in the fuel cell 500. By drawing 28 thru/or drawing 30, the situation of the flow of the oxidizing gas of the fuel cell 500 whole was shown, and the situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell formed in each stack structure was also shown collectively. The situation of the flow of the oxidizing gas of the fuel cell 500 whole was expressed based on signs that the fuel cell 500 was seen toward the side in which the stack structures 515A and 515C were allocated from the side in which the stack structures 515B and 515D were allocated. The situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell was expressed based on signs that the separator 530 with which each stack structure is provided was seen toward the side in which the return plates 590C and 590D were allocated from the side in which the return plates 590A and 590B were allocated. If the separator 530 is seen from such a direction, the field in which the crevices 546-548 in connection with the flow of oxidizing gas are formed will serve as a side front (side shown by drawing 28 - drawing 30) in the stack structures 515A and 515C, but. In the stack structures 515B and 515D, it becomes the back side (side which is not shown by drawing 28 - drawing 30). Therefore, when the flow of the oxidizing gas in the single cell in the stack structures 515A and 515C was expressed with drawing 28 - drawing 30, the solid line expressed the crevices 546-548 by them, but. When the flow of the oxidizing gas in the

single cell in the stack structures 515B and 515D was expressed, the crevices 546-548 were expressed with the dashed line. Here, such crevices 546-548 shown by drawing 28 - drawing 30 show only the thing in connection with the explanation in a figure with the above-mentioned solid line and the dashed line. In drawing 28 - drawing 30, the statement of the pore in connection with the flow of the fuel gas with which the separator 530 is provided for convenience since the situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell is expressed, etc. is omitted.

[0144]The oxidizing gas supplied from the outside to the feeding-and-discarding box 512 is distributed to four stack structures (stack structures 515A thru/or 515D) via the channel in the feeding-and-discarding box 512. The oxidizing gas distributed from the feeding-and-discarding box 512 is drawn in the oxidation gas manifold 561 which the pore 541 provided in the separator 530 with which the stack structures 515A thru/or 515D are provided forms (refer to drawing 28). That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 561 works as an oxidizing gas supply manifold. The oxidizing gas introduced into the oxidation gas manifold 561 is distributed to the oxidizing gas passage in a single cell which the crevice 547 forms, from the upper part, goes caudad, and flows through the oxidizing gas passage in a single cell, and it gathers after that to the oxidation gas manifold 564 which the pore 544 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 564 works as an oxidizing gas exhaust manifold.

[0145]Here, the oxidizing gas which gathered to the oxidation gas manifold 564 returns to the feeding-and-discarding box 512 again. As mentioned already, the channels 516-519 which connect the oxidation gas manifold 564 which the pore 544 forms, and the oxidation gas manifold 560 which the pore 540 forms within the same stack structure are formed in the feeding-and-discarding box 512. Therefore, in each stack structure, the oxidizing gas which passed the oxidation gas manifold 564 is introduced into the oxidation gas manifold 560 which the pore 540 forms within the same stack structure by the channels 516-519 with which the feeding-and-discarding box 512 is provided (refer to drawing 29). That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 560 works as an oxidizing gas supply manifold. In each stack structure, the oxidizing gas which passes the oxidation gas manifold 560 is distributed to the oxidizing gas passage in a single cell which the crevice 546 forms, and gathers after that to the oxidation gas manifold 563 which the pore 543 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 563 works as an oxidizing gas exhaust manifold.

[0146]The oxidizing gas which gathered to the oxidation gas manifold 563 which the pore 543 forms results in the return plates 590A thru/or 590D allocated by the end by the side of the application-of-pressure maintaining structure 514 in each stack structure. Here the crevices 591 thru/or 594 (refer to drawing 19 thru/or drawing 22) with which the return plates 590A thru/or 590D are provided, respectively, It laps with the pore 543 and the pore 542 with which the separator 530 is provided within each stack structure, and the oxidation gas manifold 563 which the pore 543 forms, and the oxidation gas manifold 562 which the pore 542 forms are made to open for free passage, as mentioned already. Therefore, the oxidizing gas which has passed the oxidation gas manifold 563 in each of the return plates 590A thru/or 590D, It is introduced into the oxidation gas manifold 562 which the pore 542 forms within the same stack structure by the crevices 591 thru/or 594 (refer to drawing 30). The oxidizing gas which the oxidation gas manifold 562 worked as an oxidizing gas supply manifold, and was introduced into the oxidation gas manifold 562 in the stack structures 515A thru/or 515D, After being distributed to the oxidizing gas passage in a single cell which the crevice 548 forms and passing through the oxidizing gas passage in these single cells, it gathers to the oxidation gas manifold 565 which the pore 545 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 565 works as an oxidizing gas exhaust manifold. The oxidizing gas which gathered to the oxidation gas manifold 565 reaches the feeding-and-discarding box 512 again. As mentioned already, the oxidizing gas which had connected the feeding-and-discarding box 512 with the oxidizing gas exhaust provided outside, and passed the oxidation gas manifold 565 is discharged outside via the feeding-and-discarding box 512.

[0147]Although explanation was omitted in the example about the above-mentioned fuel cell 500, the channel which circulates the cooling water for maintaining internal temperature below at a predetermined temperature is also formed in each stack structure which constitutes the fuel cell 500.

After such cooling water is also supplied from the outside via the feeding-and-discarding box 512, is distributed to each of four stack structures by the feeding-and-discarding box 512 and passes the inside of each stack structure, it is discharged outside via the feeding-and-discarding box 512.
[0148]In the separator 530 with which the fuel cell 500 of this example is provided, the passage cross section was thinly formed like the separator 430 with which the fuel cell of the 4th example is provided as the crevice which forms the gas passageway in a single cell of the downstream more. That is, in the channel side of fuel gas, a passage sectional area becomes small at the order of the crevice 556,557,558, and a passage sectional area becomes small in the channel side of oxidizing gas at the order of the crevice 547,546,548. Also in the downstream whose total amount of the gas supplied decreases, the gas mass flow per unit passage sectional area is secured by this, and the rate of flow early enough can be secured by it.
[0149]In order according to the fuel cell 500 of the 5th example constituted as mentioned above to divide the gas passageway within each stack structure into plurality and to supply gas one by one to the divided gas passageway, The gas mass flow which passes per unit sectional area of a channel increases, and the same effect as the example which that the capacity factor of gas improves etc. mentioned already is acquired. Since especially the fuel cell of this example has many single cells which are provided with two or more stack structures and with which the whole fuel cell is provided, it can acquire notably the effect of speeding up the rate of flow of gas and raising the rate of gas utilization. Usually, when there are many single cells with which a fuel cell is provided. In order to raise the rate of flow and to raise the capacity factor of gas, even if it increases the gas supply volume from a gas supply device to a fuel cell, Although the amount of energy which becomes slight [the increment of the gas mass flow in each gas passageway in a single cell], and is consumed for the amount of consumption of fuel or gas pressurization increases, it is difficult to acquire sufficient effect of raising the rate of gas utilization. That is, even if it increases the gas volume which supplies the stack structure which consists of 100 single cells in the fuel cell which it has four, theoretically, the increment of the gas volume in each gas passageway in a single cell drops only to 1/400 of the gas volume to which it was made to increase in a gas supply device. On the other hand, since the fuel cell of this example divides the channel within each stack structure into plurality and supplies gas one by one to the divided gas passageway by forming two or more crevices on a separator, Without increasing the amount of distributed gas from a gas supply device, in spite of having many single cells, the gas volume which passes the gas passageway in a single cell can be made to be able to increase, and the rate of gas utilization can be raised greatly.
[0150]In addition to the above-mentioned effect, the fuel cell of this example does the following effects so. The fuel gas supplied from the outside is first distributed only to the stack structures 515A and 515B, Since the stack structures 515C and 515D are supplied after passing the divided fuel gas flow route which was formed in the stack structure 515A and 515B, Since the flow of the fuel gas supplied to per stack structure compared with the composition which distributes fuel gas to four stack structures simultaneously increases and the gas flow rate in a channel speeds up, the capacity factor of fuel gas can be raised.
[0151]Namely, when distributing fuel gas to four stack structures simultaneously, every [of the fuel gas supplied from a fuel gas feed unit / 4 / 1/] will be supplied to each stack structure, but. In the fuel cell 500 of this example, every [of the fuel gas supplied from a fuel gas feed unit / 2 / 1/] is supplied to each stack structure. Thus, since the fuel gas flow in a channel increases and the capacity factor of gas improves, the total amount of the fuel gas supplied to a fuel cell is also reducible. Usually, in order to fully advance electrochemical reaction with the whole fuel cell, to a fuel cell, supply an excessive amount of gas exceeding gas volume required for a theoretical target, but. When the capacity factor of the gas in a fuel cell improves, even if it reduces the gas volume to supply, it becomes possible to fully advance electrochemical reaction. Such an effect becomes advantageous especially, when using a fuel cell as a power supply for a drive of an electromobile etc. That is, by the ability to reduce the fuel gas amount supplied to a fuel cell, the amount of consumption of the fuel carried in the electromobile can be cut down, and the distance it can run by refueling once can be developed.
[0152]When supplying gas to two or more stack structures, gas is previously supplied to a part of stack

structures,.In supplying the gas which passed the stack structure of these upstream to the stack structure of the remaining downstream, Since the concentration of an electrode active material becomes high in the direction of the gas supplied to the stack structure of the upstream, or the total amount of the gas supplied increases, and the direction of the stack structure of the upstream obtains sufficient voltage compared with the downstream, it will be advantageous. However, in the fuel cell 500 of this example. Since the divided channel within each stack structure is mutually connected between stack structures and gas is passed by turns between stack structures, on the other hand, only a part of stack structures are not allotted to a target by the downstream, and an output can be equalized with the whole fuel cell.
[0153]When dividing the fuel gas supplied from a fuel gas feed unit furthermore according to the fuel cell 500 of this example, Since gas is divided into two using the feeding-and-discarding box 512, without changing the direction of gas and the stack structures 515A and 515B are supplied, the gas volume supplied to each stack structure can be equalized more. Namely, the thing for which gas is divided into two with sufficient accuracy without changing the flow direction of gas, Compared with quadrisecting gas in the different direction, technically, since it is far easy, the gas volume supplied to each stack structure can be equalized more, and an output can be equalized more with the whole fuel cell by this.
[0154]In the fuel cell 500 of the 5th above-mentioned example, as mentioned already, in the feeding-and-discarding box 512, we quadrisected oxidizing gas, and decided to supply separately to each stack structure. In using here the reformed gas which reformed and obtained methanol etc. as fuel gas, the hydrogen concentration in fuel gas becomes about 60% order, but. To use air as oxidizing gas, the oxygen density in oxidizing gas needs to supply more oxidizing gas to a fuel cell compared with fuel gas, in order to supply sufficient oxygen for the cathode side, since it becomes about 20%. Between two stack structures, connect mutually like the channel of the fuel gas in the fuel cell of this example, and the channel divided within stack structure fuel gas, A pressure loss will become large, when passing through the inside of both stack structures by turns, and the length of a gas passageway becomes longer and the increase of passage resistance and gas pass through a channel. Therefore, compared with the case where gas is separately supplied to each stack structure, when supplying oxidizing gas, the amount of energy taken to pressurize oxidizing gas becomes large, and the energy efficiency of the whole fuel cell falls. In the fuel cell 500 of this example, in the channel of the oxidizing gas which needs to supply more gas, in order to avoid that channel length becomes long and reduces energy efficiency, it was presupposed to oxidizing gas that each stack structure is supplied separately.
[0155]It is good also as composition which will connect mutually the channel divided within stack structure like the channel side of fuel gas between two stack structures at the channel side of oxidizing gas and to which oxidizing gas will pass through the inside of both stack structures by turns from the first if the grade of decline in energy efficiency is in tolerance level. In such a case, the effect of making the gas mass flow and gas flow rate in a gas passageway increasing to the channel side of oxidizing gas, and raising the capacity factor of gas can be acquired.
[0156]According to the fuel cell 500 of this example, since two or more stack structures are stored in one case, the whole composition is miniaturizable. Especially, have established the feeding-and-discarding box 512 in the center section, and via this feeding-and-discarding box 512, Since supply of gas is received from the exterior, and gas is discharged to the exterior and gas is exchanged between each stack structure via this feeding-and-discarding box 512, piping structure of gas can be made very compact.
[0157]Like this example, establish two or more crevices in the separator surface, each crevice forms the gas passageway in a single cell independently, and the divided gas passageway corresponding to the gas passageway in each single cell is connected mutually, When passing gas one by one among these, it is not necessary to pass gas one by one from the gas passageway in a single cell which the crevice established in the end of the separator forms. In this example, oxidizing gas was carried out to making it pass from the oxidizing gas passage in a single cell which the crevice 547 established in the center section of the separator 530 forms. Although the upstream is considered that gas begins to leak to a surrounding field a little via a gas diffusion electrode by a gas passageway in the channel where gas

pressure is high and gas pressure is high, Thus, if the gas passageway in a single cell which the crevice established in the center section of the separator forms is made into the upstream, the gas which began to leak from the gas passageway in a single cell of this upstream will be allocated in both sides, and will become available in the field corresponding to the gas passageway in a single cell of the reliance lower stream. Here, in each oxidizing gas passage in a single cell, since oxidizing gas goes caudad and always flows from the upper part, the produced water produced in a channel is led to a downward oxidizing gas exhaust manifold, and does not take up a channel with the flow of gas. What is necessary is just to remove the produced water led to the oxidizing gas exhaust manifold by providing a sewer valve etc. in each oxidizing gas exhaust manifold.
[0158]In this example, the channel of fuel gas was carried out to making it pass one by one from the gas passageway in a single cell which the crevice established in the end of the separator forms. That is, the fuel gas flow route in a single cell which the crevice 556 of an upper bed part forms became the upstream most, and it formed as the fuel gas flow route in a single cell which the crevice provided caudad forms so that it might become the downstream. In the fuel gas flow route in each single cell, since fuel gas flows horizontally, the produced water which is having such composition and was produced in the channel, By the flow of gas, it is gradually led to the fuel gas flow route in a single cell of the downstream, and gathers for a downstream fuel gas exhaust manifold (the stack structures 515A and 515B the fuel gas manifold 585 and the stack structures 515C and 515D fuel gas manifold 582) most eventually. Therefore, produced water can be easily removed by providing a sewer valve etc. in this fuel gas exhaust manifold.
[0159]Although the oxidizing gas passage of predetermined shape was formed in the feeding-and-discarding box 512 and we decided to introduce oxidizing gas into the gas passageway into which the downstream was divided more by this channel in the fuel cell 500 of the 5th example, Instead of forming a channel in the feeding-and-discarding box 512, it is good for the end of each stack structure also as allocating a return plate. Namely, besides the return plates 590A-590D provided in the end by the side of the application-of-pressure maintaining structure 514 in each stack structure, It is good also as realizing the same operation as the channels 516-519 which provided the return plate also in the end by the side of the feeding-and-discarding box 512, respectively, and were provided in the feeding-and-discarding box 512 with these return plates. In the fuel cell 500 of the 5th example, although it presupposed that each stack structure is connected in series in order of the stack structures 515A, 515C, 515D, and 515B, it may carry out the method of different connection. For example, it is good also as connecting such stack structures in parallel mutually.
[0160]As mentioned already, in the fuel cell 500 of the 5th example. Since the channel within each stack structure is divided into plurality and gas is supplied one by one to the divided gas passageway by forming two or more crevices on a separator, in spite of having many single cells, Without increasing the amount of distributed gas from a gas supply device, the gas volume which passes the gas passageway in a single cell was able to be made to have been able to increase, and the rate of gas utilization was able to be raised greatly. It becomes possible using such an effect to constitute a fuel cell with few stack structures using the separator provided with two or more crevices like the 5th example. Here, the gas mass flow in each gas passageway in a single cell will decrease, and the capacity factor of gas will fall, so that the number of the single cells with which one stack structure is provided is increased. In order to increase the number of single cells per stack structure, securing the gas mass flow in the gas passageway in a single cell, Since it was accompanied by the increase in the amount of energy consumed in order to make the gas volume supplied to stack structure increase greatly and to pressurize an increase and gas of fuel consumption, the former was difficult for increasing the number of single cells per stack structure. If gas is supplied one by one to the gas passageway which divided the channel within each stack structure into plurality, and divided it using the separator provided with two or more crevices like the 5th example, the number of single cells per stack structure can be increased without being accompanied by the above-mentioned inconvenience.
[0161]Drawing 31 is a fuel cell provided with two stack structures, and is an explanatory view showing the composition of the fuel cell 500 shown in drawing 17, and the fuel cell 600 provided with same

number of single cells. Like the fuel cell 500, the fuel cell 600 is constituted using the separator 530, and since the channel within stack structure is divided into three, even if it makes the number of single cells per stack structure increase, it can fully secure the gas mass flow in the gas passageway in a single cell. Thus, by increasing the number of single cells per stack structure, and reducing the number of stack structures, the dead spaces produced in order to dedicate two or more stack structures in a case are reduced, and it becomes possible to miniaturize the whole fuel cell more.
[0162]Although the above-mentioned example explained the polymer electrolyte fuel cell, the composition of this invention is also applicable to the fuel cell of a different kind. For example, also when it applies to a phosphoric acid type fuel cell, a solid oxide fuel cell, etc., the same effect of raising the rate of gas utilization or raising wastewater nature can be acquired.
[0163]As for this invention, although the example of this invention was described above, it is needless to say that it can carry out with the aspect which becomes various within limits which are not limited to such an example at all and do not deviate from the gist of this invention.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]This invention the gas separator for fuel cells, and this gas separator for fuel cells about the used fuel cell in detail, In the fuel cell which carries out the plural laminates of the single cell, and constitutes it, it is provided between the adjoining single cells, and a fuel gas flow route and an oxidizing gas passage are formed between the adjoining members, and it is related with the fuel cell using the separator for fuel cells which separates fuel gas and oxidizing gas, and this separator.

[Translation done.]

PRIOR ART

[Description of the Prior Art]The gas separator for fuel cells is a member which constitutes the fuel cell stack by which two or more single cells were laminated, and has prevented mixing the fuel gas and oxidizing gas which are supplied to each of an adjacent single cell by having sufficient gas impermeability. Such a separator for fuel cells usually has rugged structure, such as the shape of a rib, on the surface.
It also has the work which forms the channel of fuel gas and oxidizing gas (the gas separator of such composition is also called interconnector with a rib).
That is, the separator for fuel cells forms the channel (channel in a single cell) of fuel gas or oxidizing gas between the adjoining member (gas diffusion layer) and the above-mentioned rugged structure, when included in a fuel cell stack.
[0003]The gas separator for fuel cells has a predetermined hole structure other than the rugged structure which forms the above-mentioned gas passageway. this hole -- the corresponding hole with which the adjacent gas separator was equipped when structure laminated a single cell provided with a gas separator and a fuel cell stack was constituted -- structures lap and the gas manifold which pierces through the inside of a fuel cell stack to that laminating direction is constituted. It is distributed to each single cell, such a gas manifold making an inside pass the fuel gas or oxidizing gas supplied from the outside of a fuel cell, or a fuel exhaust gas or oxidation exhaust gas after electrochemical reaction was presented by each single cell is introduced, and it leads these to the fuel cell exterior. Therefore, these gas manifolds are open for free passage with the above-mentioned channel in a single cell formed in each laminated single cell.
Gas is flowed out between a gas manifold and the channel in a single cell, and ON is possible.

[0004]Drawing 32 is an explanatory view which expresses the composition of the separator 130 superficially as an example of a gas separator known conventionally. the separator 130 -- the circumference near [the] -- four holes -- it has the vent 140,143 and the fuel hole 150,152 as a structure. When these vents and fuel holes laminate the member containing the separator 130 and constitute a fuel cell, they are an inside of a fuel cell and form an oxidizing gas supply manifold, an oxidizing gas exhaust manifold, a fuel gas supply manifold, and a fuel gas exhaust manifold, respectively.
[0005]The rib part 155 which connects the vent 140 and the vent 143 is formed in one field of the separator 130.
The rib part (not shown) which connects the fuel hole 150 and the fuel hole 152 is provided in the field of another side of the separator 130.
Here, these rib parts were taken as the grooved structure formed in parallel. When the member containing the separator 130 is laminated and a fuel cell is constituted, these rib parts form the gas passageway in a single cell between the members which adjoin the separator 130. That is, the rib part 155 which connects the vent 140 and the vent 143 forms the oxidizing gas passage in a single cell, and the rib part which connects the fuel hole 150 and the fuel hole 152 forms the fuel gas flow route in a single cell. The oxidizing gas supplied to the fuel cell passes through the inside of the oxidizing gas

supply manifold formed of the vent 140, is distributed to the oxidizing gas passage in a single cell formed in each single cell, after electrochemical reaction is presented with it, it joins by an oxidizing gas exhaust manifold, and it is discharged by the fuel cell exterior. Similarly, the fuel gas supplied to the fuel cell passes through the inside of the fuel gas supply manifold formed of the fuel hole 150, is distributed to the fuel gas flow route in a single cell formed in each single cell, after electrochemical reaction is presented with it, it joins by a fuel gas exhaust manifold, and it is discharged by the fuel cell exterior.

[0006]In the fuel cell which presents electrochemical reaction with such fuel gas and oxidizing gas, and acquires electromotive force, to raise the capacity factor of the gas supplied is desired. Namely, although the gas (fuel gas or oxidizing gas) containing an electrode active material (hydrogen or oxygen) is supplied to a fuel cell, Since all the electrode active materials in gas may be used by electrochemical reaction, in order to fully advance electrochemical reaction, the gas containing the electrode active material of the quantity exceeding the quantity needed theoretically is supplied to the fuel cell. Therefore, the electrode active material in gas is carried out that it is easy to be used by electrochemical reaction, the capacity factor of gas is raised, and to stop the gas volume supplied to a fuel cell is desired. If the gas volume supplied to a fuel cell is stopped, the amount of consumption of hydrogen can be stopped in fuel gas. In oxidizing gas, the amount of energy consumed in order to pressurize oxidizing gas (usually air) can be stopped, and the energy efficiency of the whole system provided with a fuel cell can be raised.

[0007]In order to carry out the electrode active material in gas that it is easy to be used by electrochemical reaction and to raise the capacity factor of gas, gas is well stirred in a channel and should just change into the state where it is spread. It can be made easy to contact by this in the catalyst and electrode active material with which the electrode was equipped. The method of gas being well stirred in a channel, increasing the flow of the gas which passes through the inside of this channel, for example in the channel in a single cell, in order to change into the state where it is spread, and making the rate of flow quick can be chosen. Although how to make small the passage cross section of the channel in a single cell can be considered as a method of increasing the flow of the gas which passes through the inside of a channel, The composition which makes shape of the above-mentioned rugged structure which is formed on a gas separator and forms the channel in a single cell as such composition picture-drawn-without-lifting-the-brush-from-the-paper structure is proposed (for example, JP,7-263003,A etc.). Here, the gas supplied to each single cell is introduced in the thin channel continued and formed on the same side. Therefore, even if the gas volume supplied to a fuel cell from the exterior is the same, Compared with the case where it has composition which makes the wider range on the same field pass gas simultaneously in each single cell like composition of having been shown in drawing 32, the rate of flow of the gas which passes through the arbitrary places of a channel can be made quick, and the capacity factor of gas can be raised.

[Translation done.]

EFFECT OF THE INVENTION

[The means for solving a technical problem, and its operation and effect] Composition of a fuel cell of the gas separator for fuel cells of this invention is attained by laminating with the member which forms an electrolyte layer and an electrode, two holes which are the gas separators for fuel cells which form a gas passageway inside this fuel cell, and penetrate this gas separator for fuel cells to the thickness direction -- with structure. this 2 ** hole -- the flow path forming part in a single cell which consists of a crevice which makes structure open for free passage on one field of said gas separator for fuel cells, When you form more than one in said field side of said gas separator for fuel cells, you laminate said gas separator for fuel cells and you constitute a fuel cell, without being mutually open for free passage independently, respectively, let it be a gist to form said gas passageway by the flow path forming part in said single cell.
[0013]A gas separator for fuel cells of this invention constituted as mentioned above, two holes which constitute each flow path forming part in a single cell when this gas separator is laminated and a fuel cell is constituted -- a gas passageway (gas manifold) which passes gas is formed in a laminating direction of a gas separator by structure. one field top of said gas separator -- said two holes -- a gas passageway (gas passageway in a single cell) which supplies gas to said electrolyte layer and said electrode by said crevice which makes structure open for free passage is formed. setting to said field side of said gas separator here -- said two holes -- a gas-passageway formation part in a single cell which consists of structure and said crevice, Since more than one are formed without being mutually open for free passage independently, respectively, when gas supplied to a fuel cell is distributed to a gas passageway formed in said gas separator surface, Gas is not supplied from a single gas manifold at once to the whole surface on the predetermined surface of a gas separator. When gas supplied to a fuel cell is distributed, gas is supplied from a respectively separate gas manifold for every gas passageway in a single cell of each which a flow path forming part in a single cell which divided the surface of a gas separator and was provided forms.
[0014]A fuel cell of this invention has the stack structure which carries out the plural laminates of the single cell which consists of a member containing an electrolyte layer, an electrode, and a gas separator, In response to supply of gas containing an electrode active material, are a fuel cell which acquires electromotive force according to electrochemical reaction, and said stack structure, As a channel where said gas passes an inside, have two or more divided-flow way formation parts, and each of two or more of said divided-flow way formation parts, A gas supply manifold which distributes said gas which is formed in a laminating direction of said stack structure, and passes an inside to each single cell, A gas exhaust manifold in which said gas which is formed in a laminating direction of said stack structure, and is discharged from each single cell gathers, It is formed in each single cell which constitutes said stack structure, and said gas supply manifold and said gas exhaust manifold are made to open for free passage, It consists of a gas passageway in a single cell which carries out the feeding and discarding of said gas to said electrolyte layer which constitutes said each single cell, and some fields of said electrode, Two or more crevices which form a gas passageway in said single cell with which said divided-flow way formation part is provided on at least one [in said each gas separator with which said each single cell is

provided] field are provided corresponding to each of two or more of said divided-flow way formation parts, without being mutually open for free passage. An end of said gas exhaust manifold with which one of said two or more divided-flow way formation parts is provided in an end of said stack structure, Said gas which was provided with a channel terminal area which connects an end of said gas supply manifold with which one of the others of said two or more divided-flow way formation parts is provided, and was supplied to said fuel cell makes it a gist to pass said two or more divided-flow way formation parts one by one via said channel terminal area.

[0015]Stack structure with which a fuel cell of this invention constituted as mentioned above is provided is provided with inside of two or more divided-flow way formation parts. Each divided-flow way formation part is formed from a gas passageway in a single cell which was open for free passage with two gas manifolds and these two gas manifolds, and was provided in each single cell, respectively, Within said divided-flow way formation part, said gas passing an inside of one gas manifold to a laminating direction of said stack structure. It is distributed to a gas passageway in said each single cell which is open for free passage to this one gas manifold, and electrochemical reaction in each single cell is presented, From said each gas passageway in a single cell, it is further discharged by gas manifold of another side, and passes through inside of a gas manifold of this another side to a laminating direction of said stack structure. As for gas which two or more divided-flow way formation parts were connected one by one by said channel terminal area in said gas manifold end with which each divided-flow way formation part is provided, and was supplied from the outside, said divided-flow way formation part is passed one by one.

[0016]Here, on at least one [in said gas separator with which each single cell is provided] field, a crevice which forms a gas passageway in said single cell is provided, and this crevice is provided corresponding to each of two or more of said divided-flow way formation parts. Since a crevice of these plurality is formed without being mutually open for free passage on one field of a gas separator, When gas supplied to a fuel cell is distributed to a gas passageway formed in an inside of a single cell, gas is not supplied from a single gas manifold at once to the whole surface on the predetermined surface of a gas separator. When gas supplied to a fuel cell is distributed, gas is supplied from a respectively separate gas manifold for every gas passageway in a single cell of each which said crevice which divided the surface of a gas separator and was provided forms.

[0017]Therefore, according to a fuel cell constituted using a gas separator for fuel cells of this invention, and the fuel cell of this invention. To the whole gas passageway in a single cell provided in the gas separator surface, when gas is supplied at once from a single gas manifold, it compares, Since a flow of gas passed per unit sectional area of a gas passageway in a single cell increases and the rate of flow speeds up, the diffusibility of gas in a channel improves and an electrode active material in gas reaches easily a catalyst established on an electrode. Therefore, since an electrode active material becomes is easy to be used by electrochemical reaction and a capacity factor of gas improves, an effect that gas volume which should be supplied to a fuel cell can be stopped is done so.

[0018]When the rate of flow of gas in a gas passageway in a single cell speeds up, in a channel of oxidizing gas containing especially oxygen, an effect that wastewater nature in a channel can be raised is done so. When electrochemical reaction advances in a fuel cell, in the cathode side with which oxidizing gas is supplied, produced water arises, this produced water is evaporated in oxidizing gas, and it is discharged out of a fuel cell, but when produced water stagnates without the ability to evaporate in oxidizing gas, there is a possibility of coming to bar diffusion of gas. By speeding up the rate of flow of oxidizing gas in a gas passageway in a single cell, it can prevent urging that produced water evaporates in oxidizing gas, and produced water stagnating, and barring diffusion of gas.

[0019]Since a total amount of gas which should be supplied to a fuel cell can be reduced, an effect that a humidifying amount to oxidizing gas supplied to a fuel cell can be reduced is also acquired. In a polymer electrolyte fuel cell, since a part of moisture which electrolyte membranes including produced water which is produced in the cathode side, and which was mentioned already hold is evaporated in oxidizing gas and it is discharged out of a fuel cell, it usually humidified beforehand oxidizing gas supplied to a fuel cell, and has prevented desiccation of an electrolyte membrane. If a total amount of

oxidizing gas supplied to a fuel cell can be reduced as described above, a moisture content carried out out of a fuel cell by oxidizing gas can be lessened more, and a humidifying amount of oxidizing gas supplied to a fuel cell can be reduced. An amount of energy consumed by this in order to humidify oxidizing gas is reducible. When using reformed gas which obtained it by carrying out steam reforming of the hydrocarbon as fuel gas supplied to a fuel cell, special composition which humidifies fuel gas is unnecessary, but to use hydrogen gas as fuel gas, before supplying a fuel cell, it is necessary to humidify. Also in this case, since a total amount of gas which should be supplied to a fuel cell can be reduced, a humidifying amount can be stopped and an effect that an amount of energy consumed for humidification is reducible can be acquired.

[0020]According to a fuel cell constituted using a gas separator for fuel cells of this invention, and the fuel cell of this invention. Since gas is supplied from a gas manifold which a field to which oxidizing gas or fuel gas is supplied is divided in arbitrary single cells, and is different to each field, Also when the water of condensation stagnates in a terminal area of a gas manifold and a channel in a single cell, there is no possibility that supply of gas to a single cell may be severed thoroughly. Namely, even if the water of condensation stagnates in the above-mentioned terminal area and supply of gas to a predetermined channel in a single cell is intercepted, A possibility that all the terminal areas corresponding to two or more gas passagewaies in a single cell formed on the same side of a gas separator will be blockaded simultaneously is very low, and it can prevent supply of gas to either of the single cells which constitute stack structure originating in stagnation of the water of condensation, and stopping.

[0021]In a gas separator for fuel cells of this invention, it is good also as having a flow path forming part in a single cell of said plurality to the both sides. If it has such composition, as described above, in a fuel cell constituted using a gas separator for fuel cells of this invention, an effect of raising a capacity factor of gas can be acquired in both a channel of fuel gas containing hydrogen, and a channel of oxidizing gas containing oxygen.

[0022]Gas which contains said electrode active material in a fuel cell of this invention, It is the oxidizing gas containing oxygen and a gas passageway in said single cell into which said oxidizing gas flows is good in said each single cell also as having been formed so that a flow direction of said oxidizing gas which passes an inside might turn into a direction which goes to a lower part from the upper part like a case where gravity is followed.

[0023]If it has such composition, in a gas passageway in a single cell which oxidizing gas passes, wastewater nature can be raised further. Namely, produced water produced in the cathode side with advance of electrochemical reaction in a fuel cell, Also when it has condensed by a gas passageway in a single cell, by making a flow direction of oxidizing gas in a gas passageway in a single cell go to a lower part from the upper part, the water of condensation becomes that it is easy to be discharged according to gravity, and can prevent it from the water of condensation stagnating in a channel and barring circulation of gas.

[0024]Said two or more crevices formed on one field of this gas separator for fuel cells in a gas separator for fuel cells of this invention, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And it is arranged so that it may adjoin mutually, and the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell, respectively is good also as being arranged along a peripheral area of said gas separator for fuel cells, so that it may adjoin mutually.

[0025]Similarly in a fuel cell of this invention, said two or more crevices formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the same direction, respectively, And a gas passageway in said single cell which it is arranged so that it may adjoin mutually, and said crevice of ******** forms, It connects with said gas supply manifold and said gas exhaust manifold in both ends of said crevice which makes U type, Said gas supply manifold with which each of two or more of said divided-flow way formation parts is provided, and said gas exhaust manifold are good also as adjoining mutually and being allocated along with one of the sides of said stack structure.

[0026]According to a fuel cell constituted using a gas separator for fuel cells of such this invention, and the fuel cell of this invention. A gas supply manifold and a gas exhaust manifold which gas of the same kind passes, It is allocated in the side of stack structure along with one, and between gas manifolds which gas of the same kind passes, since it is not necessary to secure the sealing nature of gas strictly, seal structure of a field which forms a gas manifold can be simplified. By making into U type shape of a crevice which forms a gas passageway in a single cell, Compared with a case where form a crevice in linear shape and a pore for a gas manifold is formed in the both ends, it becomes possible to use a larger field on the surface of a gas separator for a gas passageway in a single cell, and a gas separator and a fuel cell using this can be miniaturized.
[0027]In a fuel cell of such this invention, by carrying out heat exchange between insides of a fuel cell, A cooling fluid way where heat produced in connection with said electrochemical reaction was removed, and temperature inside a fuel cell is a channel which makes the inside pass cooling fluid which prevents going up to a non-wanting temperature, and was provided in two or more predetermined positions inside a fuel cell, . It is formed in a laminating direction of said stack structure, and distribute said cooling fluid to said cooling fluid way. Or have a cooling fluid manifold with which said cooling fluid which passed through said each cooling fluid way gathers, and said cooling fluid manifold, It is provided near said gas supply manifold which adjoined mutually and was provided along with one of the sides which form said stack structure, and said gas exhaust manifold, It is better also as having been provided in a position which is distant from a place in which a gas passageway in said single cell is formed than a position in which said gas supply manifold and said gas exhaust manifold were allocated.
[0028]If it has such composition, in order to allocate a cooling fluid manifold in a position which is distant from a place in which a gas passageway in said single cell is formed rather than a position in which said gas supply manifold and said gas exhaust manifold were allocated, A fuel cell can be effectively miniaturized about a predetermined direction (the direction of [between the sides in which a gas supply manifold and a gas exhaust manifold are not allocated]).
[0029]A gas separator for fuel cells of this invention, Said two or more crevices which equip both sides of said gas separator for fuel cells with a flow path forming part in a single cell of said plurality, and are formed on one field of said gas separator for fuel cells, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator for fuel cells, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And the aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell which are arranged so that it may adjoin mutually, and were formed on one field of said gas separator for fuel cells, respectively, Along the 1st peripheral area of said gas separator for fuel cells, it is arranged so that it may adjoin mutually, The aforementioned hole structure with which it provides two [at a time] two or more flow path forming parts in said single cell formed on a field of another side of said gas separator for fuel cells, respectively is good also as being arranged along the 1st peripheral area of said gas separator for fuel cells, and the 2nd peripheral area that counters, so that it may adjoin mutually.
[0030]Similarly in a fuel cell of this invention said gas separator, Said two or more crevices which have said two or more crevices to the both sides, respectively, and are formed on one field of said gas separator, See from the upper part of said one field, and make U type and each U type turns to the 1st direction, respectively, And said two or more crevices which are arranged so that it may adjoin mutually, and are formed on a field of another side of said gas separator, See from the upper part of a field of said another side, and make U type and each U type turns to the 2nd direction for reverse with said 1st direction, respectively, And either of the gas passagewaies in said single cell which said two or more crevices which are arranged so that it may adjoin mutually, and were formed on one field of said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold, Along the 1st side of said stack structure, it is allocated so that it may adjoin mutually, Either of the gas passagewaies in said single cell which said two or more crevices formed on a field of another side of

said gas separator form, said gas supply manifold open for free passage, and said gas exhaust manifold meet the 1st side of said stack structure, and the 2nd side that counters, It is good also as being allocated so that it may adjoin mutually.

[0031]According to a fuel cell constituted using a gas separator for fuel cells of such this invention, and the fuel cell of this invention. Since a gas supply manifold and a gas exhaust manifold which gas of the same kind passes are allocated in the side of stack structure along with one like the above-mentioned composition, Since a larger field on the surface of a gas separator can be used for a gas passageway in a single cell while being able to simplify seal structure of a field which forms a gas manifold, an effect that a gas separator and a fuel cell using this can be miniaturized can be acquired. A gas manifold which a gas passageway in a single cell formed on one field of a gas separator opens for free passage, With a gas manifold which a gas passageway in a single cell formed on a field of another side of a gas separator opens for free passage. Since it is formed along the side which counters mutually, in a fuel cell, distance between the sides in which a gas manifold is not formed can be effectively made small, and the whole fuel cell can be miniaturized more.

[0032]Said gas supply manifold with which said divided-flow way formation part is provided in a fuel cell of this invention, As opposed to a gas passageway in said single cell formed in said all single cells with which said stack structure was equipped, Said gas exhaust manifold which supplies said gas simultaneously and with which said divided-flow way formation part is provided is good also as said gas simultaneously discharged from a gas passageway in said single cell formed in said all single cells with which said stack structure was equipped gathering. If it has such composition, structure of a gas manifold can be simplified.

[0033]It is formed in a laminating direction of said stack structure in a fuel cell of this invention, Have two or more tubular structure committed as said gas supply manifold or said gas exhaust manifold, and at least one of said the tubular structure. In said single cell which has a blocking section which intercepts a flow of gas which passes an inside in an internal position, and was allocated in it by the upstream of a flow of said gas rather than said blocking section. Said tubular structure which has said blocking section is used as said gas supply manifold, Said gas is simultaneously supplied to each of a gas passageway in said single cell with which said single cell allocated in said upstream is provided, In said single cell allocated in the downstream of a flow of said gas rather than said blocking section. It is good also as supplying said gas simultaneously to each of a gas passageway in said single cell with which said single cell which used said tubular structure committed as said gas exhaust manifold by the upstream as said gas supply manifold, and was allocated in said downstream rather than said blocking section is provided.

[0034]If it has such composition, gas supplied to stack structure will be simultaneously supplied to a gas passageway in a single cell with which a single cell arranged at the upstream of a flow of gas is provided rather than a blocking section. Gas discharged from a single cell arranged at these upstream is supplied to a gas passageway in a single cell with which a single cell arranged rather than a blocking section at the downstream is provided by making into a gas supply manifold the tubular structure committed as a gas exhaust manifold in the upper stream rather than a blocking section. Therefore, compared with composition which supplies gas to a gas passageway in a single cell with which all the single cells which constitute stack structure are provided simultaneously, gas volume supplied to each gas passageway in a single cell increases, and the rate of flow of gas in a channel can be sped up. Thus, it is realizable by easy composition of providing a blocking section in the tubular structure which constitutes a manifold for an effect of increasing gas volume in a channel.

[0035]In a fuel cell of this invention, after said gas to which said stack structure which this fuel cell equips with said two or more divided-flow way formation parts is supplied by two or more preparations and said fuel cell is divided beforehand, it is good also as being supplied to each of two or more of said stack structures. Also in this case, since each stack structure is provided with two or more divided-flow way formation parts as a channel where said gas passes an inside, in each stack structure, an effect by a flow of gas which passes a gas passageway in a single cell increasing mentioned already is acquired.

[0036]Or in a fuel cell of this invention this fuel cell, Said gas to which said stack structure provided

with said two or more divided-flow way formation parts was supplied by one of predetermined [the / of two or more preparations and said two or more stack structures], While passing said two or more divided-flow way formation parts with which stack structure predetermined [this] is provided one by one, it is good also as going via said divided-flow way formation part with which said different stack structure from said predetermined stack structure is provided.

[0037]Also in this case, since each stack structure is provided with two or more divided-flow way formation parts as a channel where said gas passes an inside, in each stack structure, an effect by a flow of gas which passes a gas passageway in a single cell increasing mentioned already is acquired. Since gas supplied to a fuel cell passes a divided-flow way formation part with which two or more stack structures are provided respectively one by one, after it divides a flow of gas beforehand, it can reduce a number which divides a flow of gas into each stack structure by an upstream part compared with a case where gas is supplied. By this, a gas mass flow which passes a gas passageway in a single cell can be increased further, and accuracy which divides a flow of gas can be raised. When accuracy which divides a flow of gas improves, gas volume supplied to each stack structure can be equalized more, and an output in each stack structure can be equalized.

[0038]

[Embodiment of the Invention]In order to clarify further composition and an operation of this invention explained above, an embodiment of the invention is described based on an example below. The fuel cell which is the 1st example of this invention is a polymer electrolyte fuel cell, and is formed of the stack structure which carried out the plural laminates of the single cell. The top view showing the composition of the separator 30 with which the fuel cell of this example is provided with the exploded perspective view showing the composition of the single cell 20 which is a basic unit of the stack structure 15 from which drawing 1 constitutes the fuel cell of the 1st example, and drawing 2, and drawing 3 are the perspective views showing the appearance of the stack structure 15. First, based on drawing 1 thru/or drawing 3, the composition of a fuel cell is explained, next the situation of the flow of the gas in this fuel cell is explained.

[0039]As mentioned above, the fuel cell of this example is a polymer electrolyte fuel cell, and is constituted by the stack structure 15 which laminated the single cell 20 which is a basic unit. As shown in drawing 1, the single cell 20 is constituted by the electrolyte membrane 31, the anode 32, the cathode 33, and the separator 30.

[0040]Here, the electrolyte membrane 31 is an ion-exchange membrane of the proton conductivity formed with solid polymer material, for example, fluororesin, and shows good electrical conductivity according to a damp or wet condition. In this example, the Nafion film (made by Du Pont) was used. The alloy which consists of platinum as a catalyst or platinum, and other metal is applied to the surface of the electrolyte membrane 31. The carbon powder which supported the alloy which consists of platinum or platinum, and other metal as a method of applying a catalyst is produced, The suitable organic solvent was made to distribute the carbon powder which supported this catalyst, a proper quantity of electrolytic solutions (for example, Aldrich Chemical, Nafion Solution) were added and pasted, and the method of screen-stenciling on the electrolyte membrane 31 was taken. Or the composition which carries out film shaping of the paste containing the carbon powder which supported the above-mentioned catalyst, produces a sheet, and presses this sheet on the electrolyte membrane 31 is also preferred.

[0041]Both the anode 32 and the cathode 33 are formed by the carbon crossing woven with the thread which consists of carbon fiber. In this example, although the anode 32 and the cathode 33 were formed by carbon crossing, the composition formed by the carbon paper or carbon felt which consists of carbon fiber is also preferred.

[0042]The separator 30 is formed by the gas unpenetrated conductive member, for example, the substantia-compacta carbon which compressed carbon and it presupposed gas un-penetrating. Drawing 2 (A) and (B) is a top view showing signs that the separator 30 was seen from double-sided each. The separator 30 is provided with ten holes near [the] the circumference. That is, the pores 40, 41, and 42 which are three holes which adjoin along with this neighborhood are formed near the one side of the

separator 30, and the pores 43, 44, and 45 which similarly adjoin are formed near the neighborhood which counters around here. The pore 50 and the pore 51 which are two holes which adjoin along with this neighborhood are provided near [which is different in the two above-mentioned sides] the one side, and the pore 52 and the pore 53 which similarly adjoin are provided near the neighborhood which counters around here (refer to drawing 2). The separator 30 is provided with the grooved rib formed in parallel with the both sides.
[0043]The rib part 55 is the same with the pore 41, this and the pore 44 which counters are connected, in respect of one of the two of the separator 30, the pore 40, and this and the pore 43 which counters are connected here, and the rib part 57 is formed [the rib part 56 is the same with the pore 42, this and the pore 45 which counters are connected, and]. In respect of another side of the separator 30, the pore 50, and this and the pore 52 which counters are connected, the rib part 58 connects the pore 51, and this and the pore 53 which counters, and the rib part 59 is formed. Each of these rib parts are making a parallel grooved structure mutually, as described above.
[0044]As shown in drawing 1, when the separator 30 is laminated with the electrolyte membrane 31, the anode 32, and the cathode 33, forms the single cell 20 and constitutes the stack structure 15 further, each rib part forms a gas passageway between adjoining gas diffusion electrodes. Namely, the rib parts 55-57 which connect two pores countered of the pores 40-45, The rib parts 58 and 59 which connect two pores which form the oxidizing gas passage in a single cell between the surfaces of the adjoining cathode 33, and are countered of the pores 50-53 form the fuel gas flow route in a single cell between the surfaces of the adjoining anode 32.
[0045]When the single cell 20 is laminated and the stack structure 15 is assembled, the pores 40, 44, and 42 with which each separator 30 is provided form the oxidizing gas supply manifolds 60, 61, and 62 which penetrate stack structure 15 inside to the laminating direction, respectively. Similarly the pores 43, 41, and 45 form the oxidizing gas exhaust manifolds 63, 64, and 65 which penetrate stack structure 15 inside to the laminating direction, respectively. The pores 52 and 51 form the fuel gas supply manifolds 66 and 67 which similarly penetrate stack structure to the laminating direction, respectively, and the pores 50 and 53 form the fuel gas exhaust manifolds 68 and 69, respectively (refer to drawing 2). It explains later that the gas within these gas passagewaies formed in the stack structure 15 flows in detail (see drawing 6 and drawing 7 which are mentioned later).
[0046]When assembling the stack structure 15 provided with each member explained above, it piles up one by one in order of the separator 30, the anode 32, the electrolyte membrane 31, the cathode 33, and the separator 30, and while laminated a predetermined number of single cells 20, and the return plate 70 is arranged at the end. The stack structure 15 which arranges the collecting electrode plates 36 and 37, the electric insulating plates 38 and 39, and the end plates 80 and 85 one by one to the both ends, and is shown in drawing 3 is completed.
[0047]The return plate 70 is formed with substantia-compacta carbon like the separator 30. Drawing 4 is an explanatory view showing the shape of the return plate 70. Drawing 4 (A) expresses plane appearance and drawing 4 (B) expresses the situation of the (B)-(B) section in drawing 4 (A). As shown in drawing 4, the return plate 70, It has the crevices 71, 72, and 74 and the pores 75, 76, 77, and 78 near [the] the periphery, and when the stack structure 15 is constituted, the return plate 70 is allocated so that the adjoining separator 30 and the field which has the crevices 71, 72, and 74 may touch. Although the situation of the section of the crevice 71 was shown in drawing 4 (B), other crevices 72 and 74 have the same structure, and each of these is the hollow structures which dug the return plate 70 surface and were established. the hole in which the pores 75-78 penetrate the return plate 70 -- it is structure.
[0048]When the crevice 71 with which the return plate 70 is provided constitutes the stack structure 15, it laps with the pore 43 and the pore 44 which the adjoining separator 30 has, and makes the end of the oxidizing gas exhaust manifold 63 mentioned already, and the end of the oxidizing gas supply manifold 61 open for free passage here. When the crevice 72 constitutes the stack structure 15, it laps with the pore 41 and the pore 42 which the adjoining separator 30 has, and makes the end of the oxidizing gas exhaust manifold 64 mentioned already, and the end of the oxidizing gas supply manifold 62 open for free passage. When the crevice 74 constitutes the stack structure 15, it laps with the pore 50 and the pore

51 which the adjoining separator 30 has, and makes the end of the fuel gas exhaust manifold 68 mentioned already, and the end of the fuel gas supply manifold 67 open for free passage similarly.
[0049]It laps with the pore 40 of the separator 30, and the opening of the end of the oxidizing gas supply manifold 60 is carried out, the pore 76 laps with the pore 45 of the separator 30, and the pore 75 carries out the opening of the end of the oxidizing gas exhaust manifold 65. It laps with the pore 52 of the separator 30, and the opening of the end of the fuel gas supply manifold 66 is carried out, the pore 78 laps with the pore 53 of the separator 30, and the pore 77 carries out the opening of the end of the fuel gas exhaust manifold 69. the oxidizing gas supply manifolds 60-62, the oxidizing gas exhaust manifolds 63-65, the fuel gas supply manifolds 66 and 67, and the fuel gas exhaust manifolds 68 and 69 -- each other end is blockaded by the collecting electrode plate 37.
[0050]the collecting electrode plates 36 and 37 -- gas, such as substantia-compacta carbon and a copper plate, -- it is formed of a conductive member [**** / un-], the electric insulating plates 38 and 39 are formed of insulation members, such as rubber and resin, and the end plates 80 and 85 are formed with metal, such as steel provided with rigidity. The output terminals 36A and 37A are formed in the collecting electrode plates 36 and 37, respectively, and an output of the electromotive force produced with the fuel cell constituted by the stack structure 15 is possible. four holes which lap with these pores 75-78 and whose formation of a gas passageway is attained at the pores 75-78 with which the return plate 70 is provided, and a corresponding position when the stack structure 15 is constituted in the collecting electrode plate 36, the electric insulating plate 38, and the end plate 80 -- structure is established, respectively. For example, corresponding to each of the pores 75-78, the pores 81-84 are formed in the end plate 80 (refer to drawing 3).
[0051]when operating the fuel cell which consists of the stack structure 15, the pore 83 with which the end plate 80 is provided, and the fuel gas feed unit which is not illustrated are connected -- hydrogen -- rich fuel gas is supplied to the inside of a fuel cell. Similarly, when operating a fuel cell, the pore 81 and the oxidizing gas feed unit which is not illustrated are connected, and the oxidizing gas (air) containing oxygen is supplied to the inside of a fuel cell. Here, a fuel gas feed unit and an oxidizing gas feed unit are devices which perform humidification and application of pressure of the specified quantity to each gas, and are supplied to a fuel cell. When operating a fuel cell, the pore 84 and the fuel gas exhaust which is not illustrated are connected, and the pore 82 and the oxidizing gas exhaust which is not illustrated are connected.
[0052]Although the built-up sequence of each member when the stack structure 15 is constituted is as having mentioned already, in the field which touches the separator 30, a predetermined sealing member is provided in the periphery of the electrolyte membrane 31. This sealing member prevents fuel gas and oxidizing gas beginning to leak from each inside of a single cell, and it plays the role which prevents fuel gas and oxidizing gas from being mixed in the stack structure 15.
[0053]The stack structure 15 which consists of each member explained above is held where predetermined thrust is applied to the laminating direction, and a fuel cell completes it. About the composition which presses the stack structure 15, since it was not concerned, the graphic display was abbreviated to the important section of this invention. In order to hold pressing the stack structure 15, It is good also as composition which binds the stack structure 15 tight using a bolt and a nut, or the stack member housing of predetermined shape is prepared, It is good also as composition which bends the both ends of stack member housing after storing the stack structure 15 inside this stack member housing, and makes thrust act on the stack structure 15.
[0054]In the above-mentioned explanation, although it presupposed that the separator 30 and the return plate 70 are formed with the substantia-compacta carbon which compressed carbon and it presupposed gas un-penetrating, they are good also as forming according to different construction material. For example, it is good also as forming with baking body carbon or forming by a metallic member. When forming by a metallic member, it is desirable to choose the metal which has sufficient corrosion resistance. Or it is good also as covering the surface of a metallic member with the construction material which has sufficient corrosion resistance.
[0055]Although drawing 2 did not indicate, The separator 30 of this example is provided also with the

pore for forming the cooling water manifold which cooling water other than the pores 40-45 for forming the gas manifold which oxidizing gas passes, and the pores 50-53 for forming the gas manifold which fuel gas passes passes. Although the chemical energy in the fuel supplied to a fuel cell is changed into electrical energy in the electrochemical reaction which advances with a fuel cell, conversion to electrical energy from chemical energy is not necessarily performed thoroughly, and the remaining energies that were not changed into electrical energy are released as heat. Thus, in order to continue generation of heat with power generation and to carry out the operating temperature of a fuel cell desirable within the limits, the fuel cell usually provided the channel of cooling water in the fuel cell, and has removed excessive heat by passing cooling water in a fuel cell.

[0056]When members, such as a separator mentioned already, are laminated and the stack structure 15 is constituted, this pore with which the separator 30 is provided forms the cooling water manifold which penetrates the inside of the stack structure 15 and carries out the feeding and discarding of the cooling water to the circulating-water-flow way between single cells mentioned later. In the stack structure 15 which constitutes such a fuel cell, it has a cooling channel separator which forms in the surface the rugged structure which forms the channel of cooling water instead of the usual separator 30 for every single cell of the laminated predetermined number (not shown). The rugged structure formed on this cooling channel separator forms the circulating-water-flow way between single cells between a cooling channel separator and the member which adjoins this. This circulating-water-flow way in a stack arranged for every single cell of a predetermined number received the feeding and discarding of cooling water from the cooling water manifold which consists of the above-mentioned pore, and has removed the excessive heat produced with power generation with this cooling water out of the fuel cell.

[0057]Next, it explains that the fuel gas in the fuel cell provided with the above composition and oxidizing gas flow. First, oxidizing gas is explained. The explanatory view and drawing 7 to which drawing 6 expresses the flow of the oxidizing gas within the stack structure 15 in three dimensions are the explanatory view which similarly expressed the flow of oxidizing gas superficially. As mentioned already, the oxidizing gas feed unit formed in the fuel cell exterior, The oxidizing gas (application-of-pressure air) which is connected to the pore 81 provided in the end plate 80, and is supplied from an oxidizing gas feed unit, It is introduced in the oxidizing gas supply manifold 60 via the pore provided in the position to which the electric insulating plate 38 and the collecting electrode plate 36 correspond, and the pore 75 provided in the return plate 70. The oxidizing gas which passes through the inside of the oxidizing gas supply manifold 60 is drawn in each single cell 20 in the gas passageway (oxidizing gas passage in a single cell) formed between the cathodes 33 which adjoin the rib part 55 in each separator 30. Although electrochemical reaction is presented with the oxidizing gas led to the oxidizing gas passage in these single cells in each single cell, the remaining oxidizing gas that did not participate in a reaction is discharged by the oxidizing gas exhaust manifold 63 formed of the pore 43 provided in the separator 30. In the oxidizing gas exhaust manifold 63, in the oxidizing gas supply manifold 60, while oxidizing gas passes for reverse, the oxidizing gas discharged from the oxidizing gas passage in a single cell formed in each single cell is joined.

[0058]If such oxidizing gas reaches the return plate 70 of stack structure 15 end, it will be further drawn by the crevice 71 in the oxidizing gas supply manifold 61. The oxidizing gas drawn in the oxidizing gas supply manifold 61, It is distributed to each oxidizing gas passage in a single cell formed between the cathodes 33 which adjoin the rib part 56 in each separator 30, and electrochemical reaction is presented, passing through the oxidizing gas passage in this single cell, passing through the inside of this oxidizing gas supply manifold 61. Thus, the oxidizing gas which passed through the oxidizing gas passage in a single cell is discharged by the oxidizing gas exhaust manifold 64, in the oxidizing gas supply manifold 61, joins flowing for reverse and reaches the return plate 70 again.

[0059]In the return plate 70, oxidizing gas is led to the crevice 72 and introduced into the oxidizing gas supply manifold 62. In the oxidizing gas supply manifold 62, similarly oxidizing gas, It is distributed to each oxidizing gas passage in a single cell formed between the cathodes 33 which adjoin the rib part 57 in each separator 30, and electrochemical reaction is presented, passing through the oxidizing gas passage in this single cell, passing through the inside of this oxidizing gas supply manifold 62. Thus, the

oxidizing gas which passed through the oxidizing gas passage in a single cell is discharged by the oxidizing gas exhaust manifold 65, joins, in the oxidizing gas supply manifold 62, flows for reverse and reaches the return plate 70 again. The oxidizing gas which reached the return plate 70 is discharged by the oxidizing gas exhaust linked to this pore 82 via the pore 76 of the return plate 70, the pore provided in the position to which the collecting electrode plate 36 and the electric insulating plate 38 correspond, and the pore 82 provided in the end plate 80.

[0060]As mentioned above, although it explained that the oxidizing gas within the stack structure 15 flowed, the same may be said of the fuel gas within the stack structure 15 flowing. Drawing 8 is the explanatory view which expressed superficially the flow of the fuel gas within the stack structure 15. As mentioned already, the fuel gas feed unit formed in the fuel cell exterior, The fuel gas which is connected to the pore 83 provided in the end plate 80, and is supplied from a fuel gas feed unit is introduced in the fuel gas supply manifold 66 via the pore provided in the position to which the electric insulating plate 38 and the collecting electrode plate 36 correspond, and the pore 77 provided in the return plate 70. The fuel gas which passes through the inside of the fuel gas supply manifold 66 is drawn in each single cell 20 in the gas passageway (fuel gas flow route in a single cell) formed between the anodes 32 which adjoin the rib part 58 in each separator 30. Although electrochemical reaction is presented with the fuel gas led to the fuel gas flow route in these single cells in each single cell, the remaining fuel gas that did not participate in a reaction is discharged by the fuel gas exhaust manifold 68 via the pore 50 provided in the separator 30. In the fuel gas exhaust manifold 68, in the fuel gas supply manifold 66, while fuel gas passes for reverse, the fuel gas discharged from the fuel gas flow route in a single cell formed in each single cell is joined.

[0061]If such fuel gas reaches the return plate 70 of stack structure 15 end, it will be further drawn by the crevice 74 in the fuel gas supply manifold 67. The fuel gas drawn in the fuel gas supply manifold 67, It is distributed to each fuel gas flow route in a single cell formed between the anodes 32 which adjoin the rib part 59 in each separator 30, and electrochemical reaction is presented, passing the fuel gas flow route in this single cell, passing through the inside of this fuel gas supply manifold 67. Thus, the fuel gas which passed the fuel gas flow route in a single cell is discharged by the fuel gas exhaust manifold 69, in the fuel gas supply manifold 67, joins flowing for reverse and reaches the return plate 70 again. The fuel gas which reached the return plate 70 is discharged by the fuel gas exhaust linked to this pore 84 via the pore 78 of the return plate 70, the pore provided in the position to which the collecting electrode plate 36 and the electric insulating plate 38 correspond, and the pore 84 provided in the end plate 80.

[0062]In [according to the fuel cell of this example constituted as mentioned above] the surface of each separator 30, Since the field in which the channel of oxidizing gas and fuel gas is formed was divided into 3 and 2, respectively and the gas supply manifold and the gas exhaust manifold are independently provided corresponding to each of the divided field, Even if the gas mass flow supplied to the whole fuel cell is the same, compared with the conventional composition which does not divide the field in which a channel is formed, the gas mass flow per [in the gas passageway in a single cell] unit sectional area is increased, and a gas flow rate can be raised. For example, when the rib parts 55, 56, and 57 have divided into three equally the field which can form the oxidizing gas passage in a single cell in the separator 30, respectively. Even if the gross area which forms the rib part in the separator surface is the same as the flow of the oxidizing gas supplied to a fuel cell from an oxidizing gas feed unit, compared with the case where the separator 130 shown in drawing 32 is used, the flow of the oxidizing gas which passes through the inside of the oxidizing gas passage in a single cell increases 3 times.

[0063]Therefore, by dividing the field in which a gas passageway is formed, within a gas passageway, gas is stirred well and will be in the state where it is spread. By this, the catalyst and electrode active material with which the electrode was equipped contact easily, the electrode active material in gas can be carried out that it is easy to be used by electrochemical reaction, and the capacity factor of gas can be raised. If the capacity factor of gas improves, even if it reduces conventionally the total amount of the gas supplied to a fuel cell from a fuel gas feed unit or an oxidizing gas feed unit, it will become possible to fully advance electrochemical reaction. Therefore, about fuel gas, the effect that the amount of consumption of fuel can be stopped is acquired. It is effective when using especially the reformed gas

which obtained hydrocarbon by reforming it with a steam reforming process etc. as fuel gas. That is, into reformed gas, since many ingredients which do not contribute to any electrochemical reaction other than hydrogen are contained, in order to fully advance electrochemical reaction, compared with the case where hydrogen gas is used as fuel gas, it is necessary to supply the reformed gas containing more hydrogen as fuel gas. By raising the capacity factor of gas by composition of this example, the amount of reformed gas supplied to a fuel cell can be stopped, and the effect which reduces the amount of consumption of fuel can be acquired more notably.

[0064]By becoming possible to stop the total amount of the gas supplied to a fuel cell, about oxidizing gas. The amount of energy consumed in order to pressurize this oxidizing gas, when supplying oxidizing gas to a fuel cell is stopped, and the effect that the energy efficiency of the whole system provided with a fuel cell can be maintained in the high state is acquired. Are the composition to which the gas mass flow which passes the gas passageway in a single cell is made to increase here, and the shape of the gas passageway formed in the separator surface with the composition which is made into picture-drawn-without-lifting-the-brush-from-the-paper structure and which was mentioned already. Since it is necessary to bend the shape of the gas passageway in a single cell, although the total amount of the gas which the pressure loss at the time of gas passing through the inside of this gas passageway is large, and supplies to a fuel cell does not increase, the inconvenience that the amount of energy consumed in order to pressurize the gas supplied to a fuel cell increases is produced. In the composition of this example, since it is not necessary to bend the gas passageway in a single cell, the problem of such a pressure loss does not become large.

[0065]The effect that the wastewater nature in a fuel cell can be raised is acquired by making quick the rate of flow of the gas which passes through the inside of a gas passageway. Here, the problem of the produced water in a fuel cell is explained. When a fuel cell advances electrochemical reaction in response to supply with the fuel gas containing hydrogen, and the oxidizing gas containing oxygen, produced water arises. The formula which expresses below the electrochemical reaction which advances with a fuel cell is shown.

[0066]

H_2-> $2H^+$+$2e^-$ -- (1)

(1/2) O_2+$2H^+$+$2e^-$ -> H_2O -- (2)

H_2+(1/2) O_2-> H_2O -- (3)

[0067](1) The reaction which expresses the reaction for which (2) types advance the reaction for which a formula advances by the anode side by the cathode side, and is expressed to (3) types as a whole advances. (2) As shown in the formula, in the cathode side, produced water arises with advance of electrochemical reaction, but this produced water is usually evaporated in oxidizing gas, and is discharged with oxidizing gas. At this time, when there are many generated amounts of produced water, produced water may stagnate into a gas diffusion electrode, without the ability to fully evaporate in oxidizing gas, and may produce the inconvenience of barring diffusion of gas [/ near the catalyst on an electrolyte membrane]. In a fuel cell provided with the separator 30 of this example. Since the produced water produced in the cathode side since the rate of flow of the oxidizing gas which passes the gas passageway in a single cell became quick as described above is evaporated efficiently and discharged in oxidizing gas, it can be prevented from produced water stagnating inside a fuel cell and barring diffusion of gas.

[0068]The effect that the humidifying amount to the oxidizing gas supplied to a fuel cell can be reduced is also acquired by the ability to reduce the total amount of the gas supplied to a fuel cell. As described above, produced water arises in the cathode side, but a part of moisture which electrolyte membranes including this produced water hold is evaporated in oxidizing gas, and it is discharged out of a fuel cell. In order to fully advance electrochemical reaction in a fuel cell, usually supply the oxidizing gas which contains much oxygen rather than the amount of oxygen needed for a theoretical target to a fuel cell, but. Since the moisture content carried out from the inside of a fuel cell by oxidizing gas increased so that

the amount of oxidizing gas supplied to a fuel cell increases, conventionally, the oxidizing gas supplied to a fuel cell was humidified beforehand, and desiccation of the electrolyte membrane had been prevented. In a fuel cell provided with the separator 30 of this example, since the total amount of the gas supplied to a fuel cell can be reduced, the moisture content carried out out of a fuel cell by oxidizing gas can be lessened more, and the effect that the humidifying amount of the oxidizing gas supplied to a fuel cell can be reduced is done so. By the ability to reduce a humidifying amount, the energies which humidification takes are reducible. Although the moisture content taken from an electrolyte membrane by oxidizing gas changes by the operating temperature of a fuel cell, a pressure, the rate of flow of oxidizing gas, etc., If damp or wet condition with a sufficient electrolyte membrane is maintainable even if it does not perform humidification to a fuel cell, it is possible to make unnecessary composition which humidifies oxidizing gas. In the anode side, to use hydrogen gas as fuel gas, before supplying a fuel cell, it is necessary to humidify this fuel gas, in order for the proton produced at the reaction of (1) type to move in the state where it hydrated with the water molecule in the inside of an electrolyte membrane but, and. The humidifying amount to fuel gas can also be lessened by stopping the fuel gas amount supplied to a fuel cell.

[0069]Here, the effect of becoming possible to set up the operating temperature of a fuel cell more highly is also acquired by reducing the total amount of the gas supplied to a fuel cell, and being able to reduce the moisture content taken from an electrolyte membrane by such gas. That is, when the moisture content which the gas volume supplied to a fuel cell becomes less, and is taken from an electrolyte membrane becomes less, it becomes possible also under an elevated temperature with higher maximum vapor tension to operate a fuel cell, without an electrolyte membrane getting dry too much. By setting up the operating temperature of a fuel cell more highly, electrochemical reaction can be activated more. When using the reformed gas especially mentioned already by setting up the operating temperature of a fuel cell more highly as fuel gas, it can stop that the catalyst on an electrolyte membrane receives poisoning with the carbon monoxide in reformed gas, and battery capacity can be raised more. carrying out steam reforming of the hydrocarbon -- hydrogen -- when generating rich reformed gas, there is a possibility that a small amount of carbon monoxide may be generated, and such carbon monoxide sticks to the catalyst on an electrolyte membrane, and reduces catalyst performance. It is dependent on temperature and the grade of poisoning by carbon monoxide can suppress the grade of poisoning by setting up the operating temperature of a fuel cell more highly.

[0070]In a fuel cell provided with the separator 30 of this example. It corresponds to each of the field which the field (field in which the gas passageway in a single cell is formed) to which oxidizing gas or fuel gas is supplied is divided in the arbitrary single cells 20, and was divided, Since the gas supply manifold and the gas exhaust manifold are provided independently, Also when produced water stagnates in the terminal area of a specific manifold and the specific channel in a single cell, supply of the gas to this single cell is not severed thoroughly, and the effect that there is no possibility that generation efficiency may fall by the whole single cell is acquired. As mentioned above, when electrochemical reaction advances with a fuel cell, produced water arises in the cathode side, and the produced produced water is evaporated and discharged in oxidizing gas, but. Inside a fuel cell, in the field where a temperature distribution state is comparatively low, the water vapor content which exceeds the water vapor content corresponding to maximum vapor tension will exist, and condensation of produced water may break out. If this water of condensation stagnates in the terminal area of a manifold and the channel in a single cell when condensation of such produced water breaks out, supply of the gas to the gas passageway in this single cell will be intercepted. If the above-mentioned terminal area is blockaded with produced water when the number of the manifolds which supply gas to the gas passageway in a single cell formed on a separator like the separator 130 shown in drawing 32 is one, supply of the gas to the single cell corresponding to this terminal area will stop thoroughly. In a fuel cell provided with the separator 30 of this example. Every three manifolds which supply oxidizing gas to the gas passageway in a single cell formed on a separator are formed independently, A possibility that these three terminal areas will be blockaded simultaneously is very low, and it can be prevented from supply of the oxidizing gas to either of the single cells which constitute stack structure originating in produced water, and

stopping thoroughly.
[0071]The gas volume supplied to each single cell 20 which constitutes the stack structure 15 does so the effect of being equalized more with the whole fuel cell, by dividing the field in which the gas passageway in a single cell is formed. Usually, the quantity of the gas distributed to the gas passageway in each single cell from a gas supply manifold shows dispersion for every single cell. By the gas passageway in a single cell in each single cell, distribution of a gas mass flow shows dispersion. Namely, in the fuel cell constituted using the separator 130 as shown in drawing 32. A gas mass flow does not serve as homogeneity by the whole gas passageway in a single cell which the rib part 155 forms, but a field with few gas mass flows is especially formed in the both ends (near the end of the right and left of the rib part 155 shown in drawing 32) of the rib part 155. Thus, within the gas passageway in a single cell, Or since the flow of gas shows dispersion for every gas passageway in a single cell, so that electrochemical reaction may fully advance also in the field corresponding to a channel with few gas mass flows usually, The gas volume supplied to the whole fuel cell was set as sufficient quantity, and the gas volume supplied to the gas passageway in each single cell was fully secured.
[0072]Since the field in which the gas passageway in a single cell is formed is divided within each single cell in the fuel cell of this example, Although dispersion in the flow of gas arises in each divided field (inside of the gas passageway in a single cell which each of two or more rib parts with which the separator 30 is provided on the same side forms), in the whole gas passageway in a single cell formed on the predetermined field, influence of dispersion in a gas mass flow can be made smaller. Namely, dispersion of the gas mass flow in each divided field, As opposed to each field which produced independently and was divided, respectively, Since gas is supplied independently, respectively, in each divided fields of all, a possibility that the flow of gas will decrease compared with other gas passagewaies in a single cell is low, and its a possibility that a gas mass flow may decrease extremely in the gas passageway in a single cell in a specific single cell decreases. There is a possibility that a field with few above-mentioned gas mass flows may become large far compared with the composition which divides the composition which passes gas at once to a large field like the gas passageway in a single cell which the separator 130 shown in drawing 32 forms, depends, and supplies gas to a narrow field separately. Therefore, in the gas passageway in each single cell, the field whose gas mass flow decreases can be made smaller by dividing the gas passageway in a single cell like this example. Thus, in order to fully advance electrochemical reaction in the field whose gas mass flow decreases with dispersion in a gas mass flow since dispersion in the flow of the gas which passes the gas passageway in a single cell can be made small and a gas mass flow can fully be secured, It becomes unnecessary to supply superfluous gas to a fuel cell, and the amount of consumption of gas is stopped, and it becomes possible to reduce the amount of energy consumed in order to supply gas to a fuel cell.
[0073]Although the concentration of the electrode active material contained by using an electrode active material for electrochemical reaction in the process in which the inside of a fuel cell is passed will fall gradually, the gas supplied to the fuel cell, In the fuel cell of this example, the gas passageway provided with the divided gas passageway in a single cell is connected one by one, and gas with low electrode active material concentration is not supplied only to a specific single cell. Instead of dividing the field which forms the gas passageway in a single cell like this example, divide into plurality the stack structure which constitutes a fuel cell, and also as composition which connects the divided stack structure in series, Although the gas volume which passes the gas passageway in a single cell can be increased on the conditions that the gas volume supplied to a fuel cell is certain, there is a divided possibility that a difference may arise in generation efficiency for every single cell, in this case. Namely, if two stack structures which laminated 50 single cells are connected in series instead of laminating 100 single cells and forming stack structure, Instead of being divided into 100, the gas of the specified quantity supplied to the fuel cell will be divided into 50, will be supplied to each gas passageway in a single cell, and can acquire the effect of increasing a gas mass flow and raising the rate of gas utilization. However, since the electrode active material concentration in the gas supplied compared with the upstream becomes low and the whole gas volume of stack structure of the downstream also

decreases, the stack structure of the downstream has a possibility that dispersion in performances, like voltage becomes low compared with the upstream may arise. Even if dispersion in the performance of the stack structure of such the upstream and the stack structure of the downstream increases the number of single cells with which the stack structure of the upstream is provided compared with the downstream, it is difficult to cancel. There is no possibility that battery capacity may fall selectively and may differ in the fuel cell of this example since gas with low electrode active material concentration is not supplied or a gas mass flow does not decrease in a specific single cell.

[0074]In each single cell, the field in which the gas passageway in a single cell is formed is divided into plurality, and the example which actually checked the effect acquired by the composition of the fuel cell of this example of providing independently the gas manifold which supplies gas to each field is shown below. Drawing 9 is an explanatory view showing the situation of dispersion in the voltage in each single cell which constitutes a fuel cell when output current density from a fuel cell is fixed. Drawing 9 (A) expresses dispersion in the voltage in the fuel cell constituted using the separator 30 of this example, and drawing 9 (B) expresses dispersion in the voltage in the fuel cell constituted using the separator 130 shown in drawing 32. The left-hand side (entrance side) in a figure is a connection side with a gas supply device, and has indicated the voltage in each single cell one by one according to the laminating direction of a single cell toward right-hand side.

[0075]As shown in drawing 9, according to the fuel cell using the separator 30 of this example, in the whole fuel cell, the voltage stable in each single cell can be obtained. On the other hand, the output voltage value of each single cell differed in the fuel cell using the separator 130 greatly. In drawing 9, drawing 9 (A) expresses the result of having operated the fuel cell at 75 **, and drawing 9 (B) expresses the result of having operated the fuel cell at 67 **. Thus, in the fuel cell using the separator 30 of this example, even if it makes the operating temperature higher, the inconvenience that an electrolyte membrane will dry and battery capacity will fall is not produced.

[0076]Drawing 10 sets constant the output current density from a fuel cell, and expresses temporally the situation of the output voltage in each single cell which constitutes a fuel cell when changing gradually the amount of oxidizing gas (application-of-pressure air) supplied to a fuel cell. Drawing 10 (A) expresses the situation of the change of potential in the fuel cell constituted using the separator 30 of this example, and drawing 10 (B) expresses the situation of the change of potential in the fuel cell constituted using the separator 130 shown in drawing 32. The amount of oxidizing gas supplied to a fuel cell was expressed with what time [of the amount of oxygen needed for a theoretical target based on the output current density from a fuel cell] oxygen the air containing was supplied. The air which contains twice as many oxygen as the amount of oxygen needed for a theoretical target at the time of a measurement start is supplied (in drawing 10, it expressed S:2), If it is made to decrease by 1.5 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed on a theoretical target after predetermined time progress (it expressed S:1.5 in drawing 10) and further predetermined time passes, It was made to decrease by 1.25 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target.

[0077]As shown in drawing 10 (A), in the fuel cell constituted using the separator 30 of this example. Even if it made it decrease from the twice of the quantity for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target to [1.25 times], the output voltage value from each single cell which constitutes a fuel cell was able to be maintained at the state where it was stabilized. On the other hand, in the fuel cell constituted using the separator 130 shown in drawing 32. Even if the amount of oxygen in the oxidizing gas supplied to a fuel cell is twice the quantity needed for a theoretical target, The output voltage of each single cell which constitutes a fuel cell varied greatly, and when it was made to decrease by 1.5 times of the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target, it originated in dryness of an electrolyte membrane, voltage plunged, and it was not able to continue power generation.

[0078]Thus, it was shown by by constituting a fuel cell using the separator 30 of this example that the amount of oxygen of oxidizing gas in the oxidizing gas supplied to a fuel cell, i.e., the amount supplied to a fuel cell, can be reduced substantially. In the fuel cell provided with the composition 130 of the fuel

cell known conventionally, i.e., the separator of drawing 32, here. In order to maintain the output voltage fully stable in each single cell which constitutes a fuel cell, it needed to carry out by 4 to 5 times the amount of oxygen for which the amount of oxygen in the oxidizing gas supplied to a fuel cell is needed at a theoretical target. Drawing 10 (A) expresses the result of having operated the fuel cell provided with the separator 30 at 75 **, and drawing 10 (B) expresses the result of having operated the fuel cell provided with the separator 130 at 67 **. Thus, in the fuel cell using the separator 30 of this example, an operating temperature is set up more highly, and even if it lessens more the amount of oxygen in the oxidizing gas supplied to a fuel cell, i.e., the flow of oxidizing gas to supply, it becomes possible to be stabilized and to maintain the output voltage from each single cell.
[0079]Although the field in which the oxidizing gas passage in a single cell is formed was divided into three in the arbitrary single cells 20 and it presupposed that the field in which the fuel gas flow route in a single cell is formed is divided into two in the separator 30 mentioned above, it is good also as dividing into a number different, respectively. By dividing into plurality the field in which the gas passageway in a single cell is formed, and forming independently the manifold which carries out the feeding and discarding of the gas to each divided field, The rate of flow of the gas which passes the gas passageway in a single cell can be sped up, and the effect which made it easy to reach the catalyst on an electrolyte membrane for, and described above the electrode active material in gas can be acquired. Here, the rate of flow of the gas which passes through the channel in a single cell becomes quick so that the number which divides the field in which the channel in a single cell is formed is increased, but the pressure loss at the time of gas passing through a channel will increase by increasing the number of partitions. When the pressure loss at the time of gas passing through a channel becomes large, in order to secure the gas volume supplied to a fuel cell to the specified quantity, it is necessary to increase the amount of energy consumed in order to pressurize the gas supplied to a fuel cell. Therefore, it is desirable to set up the above-mentioned number of partitions so that the whole energy efficiency may not fall in consideration of the size of the effect by increasing the number which divides the field in which the channel in a single cell is formed, and the increment of the amount of energy consumed in order to pressurize the gas supplied to a fuel cell. Although we decided to divide into two or three equally the field in which the channel in a single cell is formed in the separator 30 shown in drawing 1 and drawing 2, you may divide so that it may become an area different, respectively.
[0080]In the separator 30 mentioned above, although the rib parts 55-59 were formed in the groove formed in parallel, they can also be made into different shape. As the example, the composition of one surface of the separator 30A which is a modification of the separator 30 is shown in drawing 5. Here, except the shape of the structure corresponding to the rib parts 55-57, the separator 30A has the structure which is common in the separator 30, and gave the same number to a common structure. The uneven parts 55A, 56A, and 57A are formed in the separator 30A as a structure of connecting the pores which counter. These uneven parts 55A-57A have structure which has arranged the heights of a section quadrangle in all directions on the concave surface which connected the pore which counters and was formed. In addition, what is necessary is just to have the shape whose formation is attained between adjoining gas diffusion layers in the gas passageway in a single cell which gas passes from a predetermined pore toward this and the pore which counters as rugged structure which connects the pore which counters, when stack structure is constituted.
[0081]In the example mentioned already, as shown in drawing 6 thru/or drawing 8, the flow direction of the gas which passes an inside is reverse by the predetermined oxidation (fuel) gas supply manifold and the oxidation (fuel) gas exhaust manifold corresponding to this, but. The flow direction of the gas in these gas manifolds is good also as composition which becomes the same. Such composition is shown below. Drawing 11 using the separator 30 Each oxidation (fuel) gas supply manifold, It is an explanatory view which expresses superficially the situation of the flow of oxidizing gas when the flow of the gas which passes the inside of the oxidation (fuel) gas exhaust manifold corresponding to this constitutes the stack structure 115 which becomes the same.
[0082]Since it has the composition which is common in the stack structure 15 of the 1st example except the return plate, the stack structure 115 gives the same number to a common member, and omits detailed

explanation. In the stack structure 115, the return plate 90 is allocated by one end and the return plate 95 is allocated by the end of another side. The top view showing signs that it saw from the field of the side which touches the laminated single cell about these return plates 90 and 95 is shown in drawing 12. Drawing 12 (A) expresses the return plate 90, and drawing 12 (B) expresses the return plate 95.
[0083]The oxidizing gas supplied from the oxidizing gas feed unit formed in the fuel cell exterior is introduced in the stack structure 115 via the pore 75 provided in the return plate 90. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 55 of the separator 30, passing through the inside of the oxidizing gas supply manifold 60 formed of the pore 40 of the separator 30. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 63 formed of the pore 43, flows in the same direction as the oxidizing gas supply manifold 60, and reaches the return plate 95.
[0084]The crevice 171 which connects to the return plate 95 the end of the above-mentioned oxidizing gas exhaust manifold 63 and the end of the oxidizing gas supply manifold 61 formed of the pore 44 is formed, and oxidizing gas is introduced into the oxidizing gas supply manifold 61. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 56 of each separator 30, passing through the inside of the oxidizing gas supply manifold 61 toward the return plate 90 side. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 64 formed of the pore 41, flows in the same direction as the oxidizing gas supply manifold 61, and reaches the return plate 90.
[0085]The crevice 72 which connects to the return plate 90 the end of the above-mentioned oxidizing gas exhaust manifold 64 and the end of the oxidizing gas supply manifold 62 formed of the pore 42 is formed, and oxidizing gas is introduced into the oxidizing gas supply manifold 62. This oxidizing gas is distributed to each oxidizing gas passage in a single cell formed of the rib part 57 of each separator 30, passing through the inside of the oxidizing gas supply manifold 62 toward the return plate 95 side. The oxidizing gas discharged from each oxidizing gas passage in a single cell joins by the oxidizing gas exhaust manifold 65 formed of the pore 45, flows in the same direction as the oxidizing gas supply manifold 62, and reaches the return plate 95. In the return plate 95, the pore 176 linked to the external oxidizing gas exhaust is formed in the position corresponding to the pore 45 of the separator 30, and oxidizing gas is discharged via this pore 176.
[0086]Thus, in an oxidizing gas supply manifold and the oxidizing gas exhaust manifold corresponding to this, even if it constitutes so that the flow direction of gas may become the same, the same effect as the 1st example can be acquired. Although the direction which flows into a lower part from the upper part, and the direction which flows upwards from a lower part considered the flow direction of oxidizing gas [in / at the example mentioned already / the gas passageway in a single cell] as the composition which interchanges by turns, its composition which always flows into a lower part from the upper part is also preferred. It is shown below by making such composition into the 2nd example.
[0087]The fuel cell of the 2nd example is constituted using the separator 30 like the example mentioned already, and the return plate 170 is allocated by the end of stack structure. In this stack structure, the direction of [at the time of oxidizing gas passing] turns into for reverse like the stack structure 15 of the 1st example by the oxidizing gas supply manifold and the oxidizing gas exhaust manifold corresponding to this. Drawing 13 is an explanatory view showing the appearance of the return plate 170 seen from the field which touches the laminated single cell. Here, the same number was given to the member which is common in the return plate 70 of the 1st example.
[0088]The fuel cell of the 2nd example receives supply of oxidizing gas from an oxidizing gas feed unit via the pore 75 of the return plate 170 like the 1st example. This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part 55 from the oxidizing gas supply manifold formed of the pore 40 of the separator 30, It joins by the oxidizing gas exhaust manifold formed of the pore 43 of the separator 30, and returns to the return plate 170. The crevice 271 which connects the pore 43 and the pore 41 of the separator 30 is established in the return plate 170, and oxidizing gas is introduced into the oxidizing gas supply manifold formed of the pore 41 of the separator 30.
[0089]This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part

56, joins by the oxidizing gas exhaust manifold formed of the pore 44 of the separator 30, and returns from the oxidizing gas supply manifold formed of the pore 41 to the return plate 170. The crevice 272 which connects the pore 44 and the pore 42 of the separator 30 is established in the return plate 170, and oxidizing gas is introduced into the oxidizing gas supply manifold formed of the pore 42 of the separator 30.

[0090]This oxidizing gas branches to each oxidizing gas passage in a single cell formed of the rib part 57, joins by the oxidizing gas exhaust manifold formed of the pore 45 of the separator 30, and returns from the oxidizing gas supply manifold formed of the pore 42 to the return plate 170. The pore 76 is formed in the return plate 170 at the position corresponding to the pore 45, and oxidizing gas is discharged by the external oxidizing gas exhaust via this pore 76.

[0091]Thus, the manifold formed of the pores 40, 41, and 42 formed in the upper part in the separator 30 allocated by the inside in the fuel cell of the 2nd example, It is a manifold of the side which supplies oxidizing gas to the oxidizing gas passage in a single cell, and the manifold formed of the pores 43, 44, and 45 formed in the bottom is a near manifold with which oxidizing gas is discharged from the oxidizing gas passage in a single cell. Therefore, in the oxidizing gas passage in a single cell formed of the rib parts 55, 56, and 57, it always goes caudad from the upper part, and oxidizing gas flows.

[0092]According to the fuel cell of the 2nd example constituted as mentioned above, since oxidizing gas always flows into a lower part from the upper part in the oxidizing gas passage in a single cell, the effect that the wastewater nature in the oxidizing gas passage in a single cell can be raised is done so. As mentioned already, when electrochemical reaction advances with a fuel cell, produced water arises very in a such side, the produced produced water is evaporated in oxidizing gas, and it is discharged outside, but such produced water may condense in the oxidizing gas passage in a single cell. When the condensed produced water accomplishes waterdrop and stagnates in a channel, there is a possibility of blockading the oxidizing gas passage in a single cell, and barring circulation of gas, but. By always carrying out caudad the flow direction of the gas in the oxidizing gas passage in a single cell from the upper part, the water of condensation becomes that it is easy to be discharged according to gravity, and it can prevent producing the inconvenience stagnated and described above in the channel.

[0093]In the position of stack structure, for example, a return plate etc., it is good also as providing the drain port for discharging the condensed produced water outside. It can prevent discharging the produced water which was not discharged in the state where it evaporated in oxidizing gas by this out of a fuel cell, and barring the flow of oxidizing gas with the condensed produced water.

[0094]Although the gas supply manifold and gas exhaust manifold which are formed of the pore with which a separator is provided were penetrated and formed from the one end to the other end along the laminating direction of stack structure in the example mentioned already, In such a manifold, it is good also as providing a blocking section on the way and changing the flow direction of the gas in the gas passageway in a single cell. Such composition is explained below as the 3rd example.

[0095]Drawing 14 is an explanatory view which expresses superficially the flow of the oxidizing gas within the stack structure 315 which constitutes the fuel cell of the 3rd example. Since it has the stack structure 115 mentioned already and the almost same structure, the stack structure 315 which constitutes the fuel cell of the 3rd example attaches the same number about a common member, and omits detailed explanation. Although the stack structure 315 of the 3rd example is constituted by laminating the separator 30 like the example mentioned already, unlike the example mentioned already, in the oxidizing gas supply manifold and the oxidizing gas exhaust manifold, the blocking section is provided in the middle. That is, in the predetermined separator 30 which constitutes the stack structure 315, the pore predetermined [of the pores 40-45] is blockaded, and it has the composition that the flow of the gas which passes through the inside of a manifold by this is intercepted.

[0096]As shown in drawing 14, the pores 40-45 with which the separator 30 is provided form the manifolds 360, 363, and 361,364,362,365 in the stack structure 315, respectively. As described above, in the predetermined separator 30 which constitutes the stack structure 315, the blocking section 96 is formed in the manifolds 360, 363, and 361,364,362,365 by blockading the predetermined pore, respectively.

[0097]Since the manifold 360 is connected to the external oxidizing gas feed unit via the return plate 90, rather than the blocking section 96 in the return plate 90 side. The manifold 360 works as an oxidizing gas supply manifold, and the manifold 363 works as an oxidizing gas exhaust manifold. In the manifolds of the downstream and these manifolds, and the oxidizing gas passage in a single cell open for free passage, interception of the flow of the gas which passes through the inside of the manifold 360 by the blocking section 96 will change the flow direction of gas rather than this blocking section 96. Namely, the manifold 360 works as an oxidizing gas exhaust manifold, The flow direction of the gas in the oxidizing gas passage in a single cell which the manifold 363 works as an oxidizing gas supply manifold, and is formed of the rib part 55, It becomes the flow direction of the oxidizing gas in the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in the single cell allocated in the upstream rather than the blocking section 96 for reverse.
[0098]The blocking section 96 is formed also like the manifold 363, and the flow direction of gas changes in the manifolds of the downstream and these manifolds, and the oxidizing gas passage in a single cell open for free passage rather than the blocking section 96 provided in this manifold 363. Namely, the manifold 360 turns into an oxidizing gas supply manifold, The flow direction of the gas in the oxidizing gas passage in a single cell which the manifold 363 turns into an oxidizing gas exhaust manifold, and is formed of the rib part 55, It returns to the flow direction and the same direction of gas in the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in the single cell allocated in the field contiguous to the return plate 90.
[0099]The blocking section 96 provided in each of the manifold 361,364,362,365 works similarly. Namely, when the flow of the oxidizing gas which passes through the inside of the manifold which works as an oxidizing gas supply manifold is intercepted by the blocking section 96, rather than this blocking section 96 in the downstream. The flow direction of the oxidizing gas in the oxidizing gas passage in a single cell which an oxidizing gas supply manifold and an oxidizing gas exhaust manifold interchange, and a corresponding rib part forms serves as for reverse.
[0100]According to the fuel cell of the 3rd example constituted as mentioned above, in addition to the effect to which the gas mass flow in a channel can be made to increase, the following effects can be done so by dividing the gas passageway in a single cell in the same field like the example mentioned already. That is, by providing a blocking section in the manifold which works as a gas supply manifold, the gas mass flow which passes each gas passageway in a single cell can be made to be able to increase further, and the capacity factor of gas can be raised. For example, when supplying oxidizing gas to the manifold which the pore 40 with which the separator 30 is provided forms, in this example. Although oxidizing gas is distributed to the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in each of the single cell allocated in before the position in which the blocking section was provided from the end to which oxidizing gas is supplied, In the fuel cell which does not provide a blocking section in a manifold, oxidizing gas will be distributed to the oxidizing gas passage in a single cell (channel which the rib part 55 forms) formed in each of all the single cells which constitute stack structure. Therefore, even if the gas volume supplied from the outside by providing a blocking section in a manifold is constant, the gas volume which passes the gas passageway in a single cell can be increased further, and the above-mentioned effect can be acquired.
[0101]Although the flow of the gas which passes the gas passageway in a single cell also by connecting in series the stack structure which divided into plurality the stack structure which constitutes a fuel cell, and was divided can be made to increase as mentioned already, In the fuel cell of the 3rd example, by easy composition of providing a blocking section in a gas manifold (the predetermined pore is closed in the predetermined separator). In order to be able to make the flow of the gas which passes the gas passageway in a single cell increase and to make a gas mass flow increase, it is not necessary to complicate piping of gas. In such a fuel cell, the grade to which the gas volume which passes each gas passageway in a single cell is made to increase can be adjusted by adjusting the position and number of blocking sections which are formed in a gas manifold. Like this example, if a blocking section is provided in the middle of a manifold, the passage resistance in the gas passageway formed in stack structure will increase. Therefore, passage resistance can be freely set up by the whole stack structure by

adjusting the position which provides the number of blocking sections, and a blocking section. Although the above-mentioned example showed the composition which provides a blocking section in the manifold which oxidizing gas passes, it is good also as providing the same blocking section in the manifold which fuel gas passes.

[0102]It can also have different composition, although the gas passageway in a single cell was formed so that the manifold formed in the position which counters might be made to open for free passage, and the gas which passes through the inside of the gas passageway in a single cell was considered as the composition which flows into a certain direction in the example mentioned already. Below, the fuel cell of such composition is shown as the 4th example. Drawing 15 is a top view showing the composition of the separator 430 which constitutes the fuel cell of the 4th example, and drawing 16 is a top view showing the composition of the return plate 470 with which the fuel cell of the 4th example is provided. The stack structure which constitutes the fuel cell of the 4th example, Since it has the almost same composition as the stack structure 15 of the 1st example except replacing with the separator 30, having the separator 430, replacing with the return plate 70, and having the return plate 470, the detailed explanation about common composition is omitted.

[0103]The separator 430 equips the periphery with the pores 440-443,450-453. Here, the pores 440-443 adjoin one by one, along with one predetermined side of the separator 430, there are and they are provided, and the pores 440-443 adjoin the neighborhood provided in the neighborhood one by one along with the neighborhood which counters, and there are the pores 450-453 and they are provided. The crevice 455 and the crevice 456 are formed on one field of the separator 430. The crevice 455 and the crevice 456 are mutually formed in U type sideways [parallel], respectively. The crevice 455 is open for free passage with the pore 450 and the pore 451 in the both ends, respectively. The crevice 456 is open for free passage with the pore 452 and the pore 453 in the both ends, respectively. In the crevice 455,456, in the separator 430, the crevice 455,456 and two same crevices are formed in U type for reverse in the field of the opposite hand with the field shown in drawing 15 (not shown). One side of two crevices formed in this rear face is open for free passage with each of the pore 440 and the pore 441 in both ends, and the crevice of another side is open for free passage with each of the pores 442 and 443 in both ends.

[0104]In the fuel cell constituted using such a separator 430, the crevice 455 and the crevice 456 form the fuel gas flow route in a single cell between the adjoining anodes 32, and two crevices formed in the rear face mentioned above form the oxidizing gas passage in a single cell between the adjoining cathodes 33. Within the stack structure as for which the pore 450 and the pore 452 laminate and form the separator 430, Forming the fuel gas supply manifold which distributes fuel gas to the fuel gas flow route in a single cell, the pore 451 and the pore 453 form the fuel gas exhaust manifold in which the fuel gas discharged from the fuel gas flow route in a single cell similarly gathers within stack structure. Similarly, within stack structure, the pore 440 and the pore 442 form in the oxidizing gas passage in a single cell the oxidizing gas supply manifold which distributes oxidizing gas, and the pore 441 and the pore 443, Similarly the oxidizing gas discharged from the oxidizing gas passage in a single cell forms the oxidizing gas exhaust manifold which gather within stack structure.

[0105]The pore 457 and the pore 458 are formed in the periphery of the separator 430 near the pore 450 and the pore 453, respectively. These pores 457,458 form the cooling water manifold mentioned already within the stack structure which laminates and forms the separator 430. The cooling water supplied from the outside of a fuel cell via the cooling water manifold formed of the pore 457, The cooling water which is distributed to the cooling channel between single cells mentioned already, and is discharged from each cooling channel between single cells is led to the fuel cell exterior via the cooling water manifold formed of the pore 458.

[0106]Although it expressed with drawing 15 that the crevice with which the separator 430 is provided has a flat concave surface, Two or more heights of the predetermined shape projected and provided from the concave surface are provided in each crevice with which the actual separator 430 is provided like the uneven part with which the separator 30A shown in drawing 5 is provided. The gas which passes the gas passageway in a single cell formed of a crevice by such heights is stirred, and when the gas diffusion

electrode and heights which adjoin the separator 430 touch, conductivity sufficient between gas diffusion electrodes is secured.

[0107]The return plate 470 is provided with the pores 475-478, the pore 491,492, and the crevice 471,474. This return plate 470 is allocated by the end of stack structure like the return plate 70 in the stack structure 15 of the 1st example that showed drawing 7 and drawing 8 the top view of the situation of the flow of gas. When forming stack structure using the return plate 470, the return plate 470 is allocated so that the field expressed to drawing 16 may touch the structure which laminated the single cell. The pores 475-478, the pore 491,492, and the crevice 471,474 with which this return plate 470 is provided in drawing 16, physical relationship (it can set to the stack structure which laminated and assembled the member containing the return plate 470 and the separator 430.) with the pores 440-443,450-453,457,457 and the crevice 455,456 with which the separator 430 is provided The dotted line showed the position of the above-mentioned pore with which the separator 430 is provided, and the crevice on the return plate 470 so that the physical relationship of the above-mentioned pore and a crevice might be known.

[0108]The pore [in / on the formed stack structure and / in the pore 477 / the separator 430] 450, The pore [in / in the pore 453 in the separator 430 with which the pore 478 adjoins, and the pore 475 / the separator 430] 440, The pore 457 in the separator 430 and the pore 492 correspond respectively in position with the pore 458 in the separator 430, and the pore 476 opens mutually the pore 443 in the separator 430, and the pore 491 for free passage. The crevice 474 covers the field in which the pore 451,452 is formed in the separator 430, and is formed, and the gas manifold which the pore 451,452 forms within stack structure is made to open for free passage mutually in the end of stack structure. Similarly, the crevice 471 covers the field in which the pore 441,442 is formed in the separator 430, and is formed, and the gas manifold which the pore 441,442 forms within stack structure is made to open for free passage mutually in the end of stack structure.

[0109]The situation of the flow of the gas in the fuel cell which equips below with the separator 430 and the return plate 470 is explained. As for the stack structure which constitutes the fuel cell of this example, in each of both ends, the collecting electrode plate, the electric insulating plate, and the end plate are allocated like the stack structure 15 shown in drawing 3. To these collecting electrode plates, an electric insulating plate, and an end plate. The pore is provided in the position corresponding to the pore with which the separator 430 is provided, and it becomes possible like the example mentioned already by connecting the pore of such an end plate, and an external device to carry out the feeding and discarding of the fluid to a fuel cell. The pore 477 with which the return plate 470 is provided is connected with a fuel gas feed unit via the pore (pore provided in the position corresponding to the position in which the pore 477 was formed) provided in the collecting electrode plate, electric insulating plate, and end plate which adjoin this return plate 470 and are allocated. On the other hand (channel which the crevice 455 forms), the fuel gas flow route in a single cell formed in each single cell is distributed via the fuel gas supply manifold which the pore 450 which the separator 430 equips with the supplied fuel gas forms. The fuel gas which passed the fuel gas flow route in this single cell gathers to the fuel gas exhaust manifold which the pore 451 forms, and is led to the fuel gas supply manifold which the pore 452 forms by the crevice 474 with which the return plate 470 is provided. The fuel gas which fuel gas was distributed to another [which was further formed in each single cell from this fuel gas supply manifold] fuel gas flow route in a single cell (channel which the crevice 456 forms), and passed the fuel gas flow route in this single cell gathers to the fuel gas exhaust manifold which the pore 453 forms. The pore is provided in the position corresponding to the position in which the pore 478 with which the return plate 470 equips the above-mentioned collecting electrode plate, an electric insulating plate, and an end plate was formed, and the fuel gas which gathered to the above-mentioned fuel gas exhaust manifold is discharged by the external fuel gas exhaust via these pores.

[0110]It is constituted similarly, and oxidizing gas is supplied from the exterior to the oxidizing gas supply manifold which the pore 440 with which the separator 430 is provided forms, and the channel of oxidizing gas is also distributed to one side of the oxidizing gas passage in a single cell formed in each single cell. The oxidizing gas which passed through the oxidizing gas passage in these single cells

gathers to the oxidizing gas exhaust manifold which the pore 441 forms, and is led to the oxidizing gas supply manifold which the pore 442 forms by the crevice 471 established in the return plate 470. The oxidizing gas further distributed to another side of the oxidizing gas passage in a single cell formed in each single cell from this oxidizing gas supply manifold gathers to the oxidizing gas exhaust manifold which the pore 443 forms, and is drawn outside.

[0111]The pore is provided also in the position corresponding to the pore 491,492 with which the return plate 470 equips a collecting electrode plate, an electric insulating plate, and an end plate, respectively. Among these, a predetermined cooling water feed unit is connected to the pore corresponding to the pore 491, cooling water is supplied to the cooling water manifold which the pore 457 with which the separator 430 is provided forms, and the supplied cooling water is distributed to the circulating-water-flow way between single cells mentioned already from this cooling water manifold. The cooling water which passed through the circulating-water-flow way between single cells gathers to the cooling water manifold which the pore 458 forms, and is discharged by the predetermined cooling-water-discharge device via the pore corresponding to the above-mentioned pore 492.

[0112]By according to the fuel cell of such 4th example, dividing the gas passageway in a single cell into plurality on the same field, and making small the cross-section area of the gas passageway in a single cell, The flow and the rate of flow of gas in the channel in a single cell are raised, and, in addition to the same effect as the example mentioned already of raising the capacity factor of the gas in a fuel cell, the still more nearly following effects are done so. That is, by forming in U type each of the gas passageway in a single cell divided into plurality on the same side, the rate of the area of the field (it is hereafter called a collecting section) which contributes to electrochemical reaction among the whole cross-section area of stack structure can be made high, and the whole fuel cell can be miniaturized.

[0113]In a fuel cell provided with the divided gas passageway in a single cell which was formed in linear shape like the 1st example, Also when the whole collecting section is quadrisected in parallel, and also when it constitutes a fuel cell using the separator 430 which forms the gas passageway in a single cell of U type like this example, Although the effect which becomes small is acquired similarly and a passage sectional area both needs to provide four pores (in order to form a manifold) along with one predetermined side of a separator, It is not necessary to provide a pore in the field which met the neighborhood which counters the one above-mentioned side, and this field can be used as the above-mentioned collecting section in the fuel cell of this example. If it puts in another way, one field (field near the neighborhood which counters the one above-mentioned side) of the fields in which a pore is formed in the separator which forms the gas passageway in a single cell of the divided linear shape will become unnecessary. When a part of pore which forms a manifold becomes unnecessary, the seal structure (structure for maintaining the airtightness in a manifold) established around a pore also becomes unnecessary, and can simplify the structure of a separator and a seal. Therefore, the cross-section area of small size, i.e., a fuel cell, can be made smaller more for a fuel cell. By this, members forming, such as a separator, can be made smaller and the material cost can be reduced. In carrying in an electromobile by using this fuel cell as the power supply for vehicles by the ability to miniaturize a fuel cell, the flexibility of a vehicle design improves.

[0114]By the fuel gas and oxidizing gas side, especially the gas passageway in a single cell divided in the fuel cell of this example is formed so that it may become U type of the direction which counters mutually. If the pore which will form the manifold which carries out the feeding and discarding of one gas along with one predetermined side in a separator if it has such composition is provided, The pore which forms the manifold which carries out the feeding and discarding of the gas of another side is formed along with the one above-mentioned side and the neighborhood which counters, and does not need to provide the pore for forming a manifold near [remaining] the two sides. Therefore, a predetermined direction can be shortened in the shape of a fuel cell. A fuel cell can be made into shape short to a lengthwise direction when forming in sideways U type the crevice which forms the gas passageway in a single cell like the separator 430 shown in drawing 15. Thus, if a fuel cell is made into shape short to a lengthwise direction, when it carries in an electromobile by using a fuel cell as the power supply for vehicles, in allocating a fuel cell under a seat, it becomes advantageous especially.

[0115]In the separator which constitutes such a fuel cell, as mentioned already, the manifold which carries out the feeding and discarding of the cooling water other than the manifold which carries out the feeding and discarding of the gas is also formed, but. Since the manifold of cooling water can be formed in the position which is separated from a collecting section rather than the manifold of gas, the above-mentioned effect that the lengthwise direction of a fuel cell can be made small is not spoiled by forming the manifold of cooling water. Namely, in order to supply the gas which contributes to electrochemical reaction directly to each single cell at sufficient efficiency. Although providing in the field near a collecting section is desirable as for the manifold of gas, the manifold of the cooling water which is not directly contributed to electrochemical reaction, Since it does not interfere even if it provides in the more distant field from a collecting section, when forming a cooling water manifold, what is necessary is just to provide in the distance from a collecting section, and it is not necessary to enlarge the lengthwise direction of a fuel cell rather than a gas manifold. If shape of the section of a collecting section is made elliptical [on which the angle was dropped] like the fuel cell constituted using the separator 430 especially shown in drawing 15, the breadth to the transverse direction of a fuel cell can also be stopped. Namely, since an excessive space will produce near the corner if the shape of the section of stack structure is a quadrangle if a gas manifold is provided along with an elliptical collecting section, Maintaining the shortness of the lengthwise direction of a fuel cell by forming a cooling water manifold using this space, it stops that a fuel cell becomes large in a transverse direction, and the whole fuel cell can be miniaturized. In making shape of the whole collecting section into the quadrangle instead of an ellipse form and forming a gas passageway in U type, the flow of gas becomes insufficient easily and the corner which hits the pars basilaris ossis occipitalis of this U character has a possibility that electrochemical reaction may not fully advance. Therefore, as described above, even if it reduces the area of the collecting section which is equivalent to a corner by using a collecting section as an ellipse form, it is so much uninfluential to battery capacity.
[0116]In the separator 430 to constitute, the fuel cell of this example the downstream field (linear area of the direction near the pore 451) of the crevice 455, Compared with the upstream field (linear area of the direction near the pore 450), width is formed narrowly, and, similarly, as for the downstream field (linear area of the direction near the pore 453) of the crevice 456, width is narrowly formed compared with the upstream field (linear area of the direction near the pore 452) (refer to drawing 15). In the lower stream, in the gas passageway in a single cell of a fuel cell provided with such a separator 430, a passage sectional area becomes small. Within a fuel cell, the electrode active material concentration in a gas mass flow and gas decreases in connection with the electrode active material in the supplied gas being consumed by electrochemical reaction. Therefore, by making a passage sectional area small in this way as the lower stream, it can compensate with a gas mass flow decreasing, a uniform reaction can be expected with the whole fuel cell, and sufficient voltage can be secured.
[0117]Since the gas passageway in a single cell is formed in U type, the fuel cell of this example does so the effect that the rate of gas utilization can be raised further, compared with the case where the gas passageway in a single cell is formed in linear shape. That is, when gas is led to the shape of a channel and the flow direction changes for reverse, it becomes easy to generate a turbulent flow in the field which hits the pars basilaris ossis occipitalis of U type, and the capacity factor of gas improves by stirring gas more.
[0118]In the fuel cell of this example, it writes with the composition which makes shape of the gas passageway in a single cell sideways U type, goes caudad from the upper part, and passes gas by both by the side of fuel gas and oxidizing gas, and the effect that the draining mechanism of the produced water produced within a gas passageway can be simplified is done so. For example, when the oxidizing gas passage in a single cell is provided in the perpendicular direction like the 1st example, the produced produced water is led to the oxidizing gas passage in a single cell, falls caudad, and collects on each of three downward manifolds (the oxidizing gas exhaust manifolds 63 and 65, oxidizing gas supply manifold 61). In such a fuel cell, the sewer valve needed to be provided in these manifolds, respectively, and produced water needed to be removed. In the fuel cell of this example, since each gas passageway in a single cell serves as sideways U type, the produced produced water is led to the pressure and gravity

into which gas flows, and is gradually led to the downstream in the gas passageway in a single cell. Thus, since it is eventually led to the manifold which the pore 453 or the pore 443 with which the separator 430 is provided forms, if a draining mechanism is provided only in the manifold located in the method of these bottom, it is sufficient for produced water. Or composition can be simplified further, without providing a draining mechanism in the inside of a fuel cell with the pressure of gas, if the discharge to the exterior of a fuel cell is possible for the produced water led to these manifolds enough.
[0119]Although the crevice of U type for forming the gas passageway in a single cell was established in each two field of every in the separator 430 which constitutes the fuel cell of this example, the number of partitions (the number of the crevices formed on the same side) of the gas passageway in a single cell is good also as two or more. What is necessary is just to determine the number of partitions suitably in consideration of the grade etc. whose energy required in order to pressurize gas, when supplying gas increases, when it increases the number of partitions and passage resistance increases, the effect by a passage cross section becoming small and the rate of flow of gas becoming early by increasing the number of partitions, and. In the separator 430, the adjacent spaces which form a manifold, and the field which forms a collecting section may be formed by one, or may be formed by a different body.
[0120]In the fuel cell of this example, and the fuel cell of the 1st example, the gas which passed the gas exhaust manifold is introduced in a return plate in the gas supply manifold adjoined and provided in this gas exhaust manifold. Therefore, in order to draw gas, the crevice established in a return plate is small, and ends (it being short), and the capacity of a crevice can be stopped. While gas passes through the inside of this crevice, it does not contribute to power generation, but when the size and the amount of distributed gas of a fuel cell are set constant, generation efficiency can fully be secured by stopping the gas volume which does not contribute to a reaction.
[0121]As described above, when being led to the gas manifold which the gas which passed the predetermined gas manifold adjoins by the crevice with which a return plate is provided, the gas sealing structure near the crevice of this return plate can be simplified. That is, the case where different gas (oxygen and hydrogen) adjoins near the field where the entrance of gas of the same kind adjoins does not need to secure airtightness more strictly.
[0122]Although the gas which divides the channel of gas in parallel with the laminating direction of stack structure, and is supplied in single stack structure at stack structure was considered as the composition which passes through the inside of these divided channels one by one in the example mentioned already, It is good also as connecting two or more such stack structures, constituting a fuel cell, and securing more electric power. The composition of the fuel cell which consists of two or more stack structures is explained below as the 5th example. Drawing 17 is an explanatory view showing the composition of the fuel cell 500 of the 5th example provided with four stack structures, and drawing 18 is a top view showing the composition of the separator 530 with which each stack structure with which the fuel cell 500 is provided was equipped. The fuel cell 500 was provided with the four stack structures 515A, 515B, 515C, and 515D, connected such stack structures mutually with the feeding-and-discarding box 512, and has stored such structures in the case 510. Although the case 510 has covered the four whole stack structure, drawing 17 removes one side of the field big No. 1 in the case 510, and it expresses signs that the inside of the case 510 was seen from this removed field side. Since each stack structure with which the fuel cell 500 is provided has the composition which is common in the example mentioned already except how to flow through the structure of the separator with which this is provided, and the gas in an inside, the detailed explanation about each stack structure is omitted.
[0123]The feeding-and-discarding box 512 is the box-like member allocated in the center section of the fuel cell 500, and is formed by the material which has predetermined rigidity, for example, aluminum etc.It faces across this feeding-and-discarding box 512, the stack structures 515A and 515B are allocated in one side, and the stack structures 515C and 515D are allocated in another side. This feeding-and-discarding box 512 is connected with the fuel gas feed unit, the fuel gas exhaust, the oxidizing gas feed unit, and the oxidizing gas exhaust which were provided outside. The channel of predetermined shape is formed in the inside of the feeding-and-discarding box 512, and distribute the fuel gas and oxidizing gas which were supplied by this channel from the outside to each stack structure with which the fuel cell 500

is provided, and. The gas which draws outside the gas discharged by passing through the inside of stack structure, and is exchanged between each stack structure is drawn.

[0124]In those both ends, the application-of-pressure maintaining structure 514 is established, to each stack structure, thrust is applied to the fuel cell 500 toward the feeding-and-discarding box 512 side from the end side, and each stack structure is held within the case 510 according to this application-of-pressure maintaining structure 514 to it. the application-of-pressure maintaining structure 514 of this example is provided with the pressurizing shafts 501, and these pressurizing shafts 501 are thrust into a predetermined hole structure (not shown) provided in the end of the case 510 -- this hole -- the welding pressure to each stack structure is held by screwing in structure. The pressure plate 502 is formed in the end (end side of the case 510) of each stack structure. The thrust applied from the pressurizing shafts 501 is told to stack structure via this pressure plate 502, and the whole stack structure in a case is pressurized (refer to drawing 17).

[0125]As shown in drawing 18, the pores 540-545 and the pores 550-555 are formed in the separator 530, and on one field, The crevice 548 which makes the crevice 547 which makes the crevice 546 which makes the pores 540 and 543 open for free passage, and the pores 541 and 544 open for free passage, and the pores 542 and 545 open for free passage is formed (refer to drawing 18 (A)). On another field, the crevice 558 which makes the crevice 557 which makes the crevice 556 which makes the pores 550 and 553 open for free passage, and the pores 551 and 554 open for free passage, and the pores 552 and 555 open for free passage is formed (refer to drawing 18 (B)). The pores 540-545 form respectively the acid gas manifolds 560-565 which carry out the feeding and discarding of the oxidizing gas within stack structure, and the pores 550-555 form respectively the fuel gas manifolds 580-585 which carry out the feeding and discarding of the fuel gas (refer to drawing 18). The crevices 546-548 form the oxidizing gas passage in a single cell within stack structure, and the crevices 556-558 form the fuel gas flow route in a single cell. Although the statement was omitted in drawing 18, The crevices 546-548,556-558 with which the separator 530 is provided are provided with the heights of predetermined shape which secure conductivity between the gas diffusion electrodes which the gas which passes the gas passageway in a single cell as well as the separator 430 mentioned already is stirred, and adjoin.

[0126]The fuel cell 500 equips with one return plate in connection with the channel of fuel gas at a time the end (end of the side in which the application-of-pressure maintaining structure 514 is formed) of each stack structure. the end of the stack structure 515A -- the return plate 590A -- the return plate 590C is allocated by the end of the stack structure 515C, and the return plate 590D is allocated in the end of the stack structure 515D for the return plate 590B by the end of the stack structure 515B. Drawing 19 thru/or drawing 22 are the top views showing the composition of these return plates, and expresses signs that all were seen from the side which touches the laminated single cell 20 (going to the pressure plate 502 side from the feeding-and-discarding box 512 side). the return plate 590A -- the crevice 571 and the crevice 591 -- the return plate 590B -- as for the return plate 590C, the return plate 590D equips [the crevice 572 and the crevice 592] the surface with the crevice 579 and the crevice 594 for the crevice 574 and the crevice 593. The crevice 571,572,574,579 is a structure which forms the channel of fuel gas here, and the crevice 591 - the crevice 594 are structures which form the channel of oxidizing gas.

[0127]Express the superficial composition of the return plates 590A-590D with drawing 19 thru/or drawing 22, and. The situation of the flow of the gas within the fuel cell 500 is explained, and also [expedient] physical relationship with a part of pore with which the separator 530 laminated in the same stack structure is provided and which was mentioned already, and the above-mentioned crevice with which each return plate is provided was also shown collectively. Here, the pore of the separator 530 located within each stack structure corresponding to each crevice with which each return plate is provided was expressed with the dotted line on each return plate in each of drawing 19 thru/or drawing 22. Namely, the crevice 571 with which the return plate 590A is provided in the stack structure 515A, The fuel gas manifold 581,582 which the pore 551,552 with which the separator 530 is provided forms is made to open for free passage, and the crevice 591 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 19). Similarly in the stack structure 515B, the crevice 572 with which the return plate 590B is provided,

The fuel gas manifold 581,582 which the pore 551,552 with which the separator 530 is provided forms is made to open for free passage, and the crevice 592 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 20). The crevice 574 with which the return plate 590C is provided in the stack structure 515C, The fuel gas manifold 580,581 which the pore 550,551 with which the separator 530 is provided forms is made to open for free passage, and the crevice 593 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 21). Similarly by the stack structure 515D, the crevice 579 with which the return plate 590D is provided, The fuel gas manifold 580,581 which the pore 550,551 with which the separator 530 is provided forms is made to open for free passage, and the crevice 594 makes the oxidation gas manifold 562,563 which the pore 542,543 with which the separator 530 is provided forms open for free passage (refer to drawing 22). The situation of direction of lamination of each member in the fuel cell 500 and the flow of gas is explained in detail later.

[0128]The direction of lamination of the single cell 20 is the same as the stack structures 515A and 515C among four stack structures with which the fuel cell 500 is provided, and, in the laminating direction of the stack structures 515B and 515D, these serve as for reverse. The stack structures 515A-515D which constitute the fuel cell 500 equip each both ends with the same collecting electrode plate as the example mentioned already. Namely, in the both ends of the stack structure 515A the collecting electrode plates 536A and 537A, The collecting electrode plates 536C and 537C are allocated in the both ends of the stack structure 515C, and the collecting electrode plates 536D and 537D are allocated in the both ends of the stack structure 515B for the collecting electrode plates 536B and 537B by the both ends of the stack structure 515D, respectively (refer to drawing 17). These collecting electrode plates are provided with the terminal for taking out electric power from each stack structure like [although the statement was omitted in drawing 17] the example mentioned already. The situation of connection of the terminal provided in the collecting electrode plate with which each stack structures 515A-515D equip below is explained.

[0129]The terminal of the collecting electrode plate 537A formed in feeding-and-discarding box 512 side edge part in the stack structure 515A is connected with the terminal of the collecting electrode plate 536C formed in feeding-and-discarding box 512 side edge part in the stack structure 515C which confronts each other across the feeding-and-discarding box 512. The terminal of the collecting electrode plate 537C formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515C is connected with the terminal of the collecting electrode plate 536D formed in application-of-pressure maintaining structure 514 side edge part in the adjacent stack structure 515D. The terminal of the collecting electrode plate 537D formed in feeding-and-discarding box 512 side edge part in the stack structure 515D is connected with the terminal of the collecting electrode plate 536B formed in feeding-and-discarding box 512 side edge part in the stack structure 515B which confronts each other across the feeding-and-discarding box 512.

[0130]Since the direction of lamination of the single cell 20 is for reverse here by the stack structures 515A and 515C and the stack structures 515B and 515D as mentioned already, By connecting the contact button of each stack structure end as mentioned above, the stack structures 515A-515D are connected in series in order of the stack structures 515A, 515C, 515D, and 515B. If the stack structures 515A-515D are connected in series as mentioned above, The terminal of the collecting electrode plate 536A formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515A, The terminal of the collecting electrode plate 537B formed in application-of-pressure maintaining structure 514 side edge part in the stack structure 515B turns into an output terminal of the fuel cell 500, and electric power can be taken out from these terminals.

[0131]Below, the situation of the flow of the fuel gas in such a fuel cell 500 is explained. Drawing 23 thru/or drawing 25 are the explanatory views showing the situation of the flow of the fuel gas in the fuel cell 500. By drawing 23 thru/or drawing 25, the situation of the flow of the fuel gas of the fuel cell 500 whole was shown, and the situation of the flow of the fuel gas in the fuel gas flow route in a single cell formed in each stack structure was also collectively shown near each stack structure. As a situation of

the flow of the fuel gas of the fuel cell 500 whole, the state where the fuel cell 500 was seen from the same direction as drawing 17 was shown. The situation of the flow of the fuel gas in the fuel gas flow route in a single cell was expressed based on signs that the separator 530 with which each stack structure is provided was seen toward the side in which the return plates 590C and 590D were allocated from the side in which the return plates 590A and 590B were allocated. If the separator 530 is seen from such a direction, the field in which the crevices 556-558 in connection with the flow of fuel gas are formed will serve as a side front (side shown by drawing 23 - drawing 25) in the stack structures 515B and 515D, but. In the stack structures 515A and 515C, it becomes the back side (side which is not shown by drawing 23 - drawing 25). Therefore, when the flow of the fuel gas in the single cell in the stack structures 515B and 515D was expressed with drawing 23 - drawing 25, the solid line expressed the crevices 556-558 by them, but. When the flow of the fuel gas in the single cell in the stack structures 515A and 515C was expressed, the crevices 556-558 were expressed with the dashed line. Here, such crevices 556-558 shown by drawing 23 - drawing 25 show only the thing in connection with the explanation in a figure with the above-mentioned solid line and the dashed line. In drawing 23 - drawing 25, the statement of the pore in connection with the flow of the oxidizing gas with which the separator 530 is provided for convenience since the situation of the flow of the fuel gas in the fuel gas flow route in a single cell is expressed, etc. is omitted.

[0132]The fuel gas supplied from the outside to the feeding-and-discarding box 512 is distributed to the stack structures 515A and 515B via the channel in the feeding-and-discarding box 512. At this time, the fuel gas supplied from the external fuel gas feed unit, without it is divided into two according to the shape of the channel formed in the feeding-and-discarding box 512 and changes the flow direction of gas -- the stack structures 515A and 515B -- it is each upper bed side and is led to the fuel gas manifold boiled and provided from the center of the fuel cell 500. That is, the fuel gas supplied from the outside is drawn in the fuel gas manifold 580 which the pore 550 provided in the separator 530 with which the stack structures 515A and 515B are provided forms (refer to drawing 23). As mentioned already, since the direction of lamination of the single cell 20 is different, the manifold with which fuel gas is introduced first turns into the fuel gas manifold 580 which the pore 550 forms also in which stack structure by the stack structures 515A and 515B. In the stack structures 515A and 515B, the fuel gas introduced into the fuel gas manifold 580 which the pore 550 forms is distributed to the fuel gas flow route in a single cell which the pore 550 and the crevice 556 open for free passage form, and gathers after that to the fuel gas manifold 583 which the pore 553 forms. That is, in the stack structures 515A and 515B, the fuel gas manifold 583 works as a fuel gas exhaust manifold.

[0133]In each of the stack structures 515A and 515B here, The fuel gas manifold 583 formed of the pore 553 and the fuel gas manifold 583 formed of the pore 553 in each of the stack structures 515C and 515D are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 583 formed of the pore 553 in the stack structures 515A and 515B, It is led to the stack structures 515C and 515D via the feeding-and-discarding box 512, and is led to the fuel gas manifold 583 formed of the pore 553. When making such connection, the gas exhaust manifold formed in the stack structures 515A and 515B is connected to these and the gas manifold formed in the corresponding position in the stack structures 515C and 515D. Therefore, although the fuel gas manifold 580 turns into a fuel gas supply manifold and the fuel gas manifold 583 turns into a fuel gas exhaust manifold in the stack structures 515A and 515B, In the stack structures 515C and 515D, these become reverse, the fuel gas manifold 580 turns into a fuel gas exhaust manifold, and the fuel gas manifold 583 turns into a fuel gas supply manifold.

[0134]In the stack structures 515C and 515D, from the fuel gas manifold 583 which the pore 553 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 556 forms, and passed the fuel gas flow route in these single cells, It gathers to the fuel gas manifold 580 which the pore 550 forms, and results in the return plates 590C and 590D allocated by the end by the side of the application-of-pressure maintaining structure 514. Here the crevice 574,579 (drawing 21, 22 references) with which the return plates 590C and 590D are provided, respectively, It laps with the pores 550 and 551 with which the adjoining separator 530 is provided, and the fuel gas manifold 580

which the pore 550 forms, and the fuel gas manifold 581 which the pore 551 forms are made to open for free passage, as mentioned already. Therefore, the fuel gas which has passed the fuel gas manifold 580 is led to the fuel gas manifold 581 which the pore 551 within the same stack structure forms by the crevice 574,579 in each of the return plates 590C and 590D. (Refer to drawing 24).

[0135]The fuel gas which the fuel gas manifold 581 worked as a fuel gas supply manifold, and was led to the fuel gas manifold 581 in the stack structures 515C and 515D, After being distributed to the fuel gas flow route in a single cell which the crevice 557 forms and passing the fuel gas flow route in these single cells, it gathers to the fuel gas manifold 584 which the pore 554 forms. That is, in the stack structures 515C and 515D, the fuel gas manifold 584 works as a fuel gas exhaust manifold.

[0136]In each of the stack structures 515C and 515D here, The fuel gas manifold 584 formed of the pore 554 and the fuel gas manifold 584 formed of the pore 554 in each of the stack structures 515A and 515B are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 584 which is a fuel gas exhaust manifold in the stack structures 515C and 515D, In the stack structures 515A and 515B, it is led to the fuel gas manifold 584 formed of the pore 554 via the feeding-and-discarding box 512. That is, in the stack structures 515A and 515B, the fuel gas manifold 584 works as a fuel gas supply manifold (refer to drawing 24).

[0137]In the stack structures 515A and 515B, from the fuel gas manifold 584 which the pore 554 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 557 forms, and passed the fuel gas flow route in these single cells, It gathers to the fuel gas manifold 581 which the pore 551 forms, and results in the return plates 590A and 590B allocated by the end by the side of the application-of-pressure maintaining structure 514. That is, in the stack structures 515A and 515B, the fuel gas manifold 581 works as a fuel gas exhaust manifold.

[0138]Here the crevice 571,572 (drawing 19, 20 references) with which the return plates 590A and 590B are provided, respectively, It laps with the pore 551 and the pore 552 with which the adjoining separator 530 is provided, and the fuel gas manifold 581 which the pore 551 forms, and the fuel gas manifold 582 which the pore 552 forms are made to open for free passage, as mentioned already. Therefore, the fuel gas which has passed the fuel gas manifold 581 is led to the fuel gas manifold 582 which the pore 552 within the same stack structure forms by the crevice 571,572 in each of the return plates 590A and 590B. (Refer to drawing 25). The fuel gas which the fuel gas manifold 582 works as a fuel gas supply manifold, and passes the fuel gas manifold 582 in the stack structures 515A and 515B, After being distributed to the fuel gas flow route in a single cell which the crevice 558 forms and passing the fuel gas flow route in these single cells, it gathers to the fuel gas manifold 585 which the pore 555 forms. That is, in the stack structures 515A and 515B, the fuel gas manifold 585 works as a fuel gas exhaust manifold.

[0139]In each of the stack structures 515A and 515B here, The fuel gas manifold 585 formed of the pore 555 and the fuel gas manifold 585 formed of the pore 555 in each of the stack structures 515C and 515D are connected by the feeding-and-discarding box 512. Therefore, the fuel gas which passed the fuel gas manifold 585 which is a fuel gas exhaust manifold in the stack structures 515A and 515B, In the stack structures 515C and 515D, it is led to the fuel gas manifold 585 formed of the pore 555 via the feeding-and-discarding box 512. That is, in the stack structures 515C and 515D, the fuel gas manifold 585 works as a fuel gas supply manifold (refer to drawing 25).

[0140]In the stack structures 515C and 515D, from the fuel gas manifold 585 which the pore 555 forms. The fuel gas which fuel gas was distributed to the fuel gas flow route in a single cell which the crevice 558 forms, and passed the fuel gas flow route in these single cells gathers to the fuel gas manifold 582 which the pore 552 forms, and reaches the feeding-and-discarding box 512 again. That is, in the stack structures 515C and 515D, the fuel gas manifold 582 works as a fuel gas exhaust manifold. As mentioned already, the fuel gas which had connected the feeding-and-discarding box 512 with the fuel gas exhaust provided outside, and passed the fuel gas manifold 582 is discharged outside via the feeding-and-discarding box 512.

[0141]In the above, although the situation of the flow of the fuel gas in the fuel cell 500 was explained next, in advance of explanation of the situation of the flow of the oxidizing gas in the fuel cell 500, it is

the channel of oxidizing gas provided in the feeding-and-discarding box 512, and the channel committed like the return plate mentioned already is explained. In the feeding-and-discarding box 512, the channel of this oxidizing gas is provided near the field which touches each stack structure. Drawing 26 is a mimetic diagram showing the section which cut the feeding-and-discarding box 512 in the E-E line shown in drawing 17, and drawing 27 is a mimetic diagram showing the section which cut the feeding-and-discarding box 512 in the F-F line shown in drawing 17. As shown in drawing 26 and 27, the channels 516-519 are established in the feeding-and-discarding box 512, and these channels are committed in each stack structure in order to make between predetermined oxidation gas manifolds open for free passage.

[0142]In addition to the channels 516-519, drawing 26 and 27 also showed collectively the position to which the pore (pore provided in the separator 530) which forms the oxidation gas manifold opened for free passage by these channels corresponds. Here, by drawing 26 and 27, the dashed line showed the position of the pore with which the separator 530 is provided. The channel 516 makes the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms open for free passage in the stack structure 515A, as shown in drawing 26. The channel 517 makes the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms open for free passage in the stack structure 515B. Similarly as shown in drawing 27, the channel 518, In the stack structure 515D, make it open for free passage, and the oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms the channel 517, The oxidation gas manifold 560 which the pore 540 forms, and the oxidation gas manifold 564 which the pore 544 forms are made to open for free passage in the stack structure 515C.

[0143]Below, the situation of the flow of the oxidizing gas in such a fuel cell 500 is explained. Drawing 28 thru/or drawing 30 are the explanatory views showing the situation of the flow of the oxidizing gas in the fuel cell 500. By drawing 28 thru/or drawing 30, the situation of the flow of the oxidizing gas of the fuel cell 500 whole was shown, and the situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell formed in each stack structure was also shown collectively. The situation of the flow of the oxidizing gas of the fuel cell 500 whole was expressed based on signs that the fuel cell 500 was seen toward the side in which the stack structures 515A and 515C were allocated from the side in which the stack structures 515B and 515D were allocated. The situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell was expressed based on signs that the separator 530 with which each stack structure is provided was seen toward the side in which the return plates 590C and 590D were allocated from the side in which the return plates 590A and 590B were allocated. If the separator 530 is seen from such a direction, the field in which the crevices 546-548 in connection with the flow of oxidizing gas are formed will serve as a side front (side shown by drawing 28 - drawing 30) in the stack structures 515A and 515C, but. In the stack structures 515B and 515D, it becomes the back side (side which is not shown by drawing 28 - drawing 30). Therefore, when the flow of the oxidizing gas in the single cell in the stack structures 515A and 515C was expressed with drawing 28 - drawing 30, the solid line expressed the crevices 546-548 by them, but. When the flow of the oxidizing gas in the single cell in the stack structures 515B and 515D was expressed, the crevices 546-548 were expressed with the dashed line. Here, such crevices 546-548 shown by drawing 28 - drawing 30 show only the thing in connection with the explanation in a figure with the above-mentioned solid line and the dashed line. In drawing 28 - drawing 30, the statement of the pore in connection with the flow of the fuel gas with which the separator 530 is provided for convenience since the situation of the flow of the oxidizing gas in the oxidizing gas passage in a single cell is expressed, etc. is omitted.

[0144]The oxidizing gas supplied from the outside to the feeding-and-discarding box 512 is distributed to four stack structures (stack structures 515A thru/or 515D) via the channel in the feeding-and-discarding box 512. The oxidizing gas distributed from the feeding-and-discarding box 512 is drawn in the oxidation gas manifold 561 which the pore 541 provided in the separator 530 with which the stack structures 515A thru/or 515D are provided forms (refer to drawing 28). That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 561 works as an oxidizing gas supply manifold. The oxidizing gas introduced into the oxidation gas manifold 561 is distributed to the oxidizing gas passage

in a single cell which the crevice 547 forms, from the upper part, goes caudad, and flows through the oxidizing gas passage in a single cell, and it gathers after that to the oxidation gas manifold 564 which the pore 544 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 564 works as an oxidizing gas exhaust manifold.

[0145]Here, the oxidizing gas which gathered to the oxidation gas manifold 564 returns to the feeding-and-discarding box 512 again. As mentioned already, the channels 516-519 which connect the oxidation gas manifold 564 which the pore 544 forms, and the oxidation gas manifold 560 which the pore 540 forms within the same stack structure are formed in the feeding-and-discarding box 512. Therefore, in each stack structure, the oxidizing gas which passed the oxidation gas manifold 564 is introduced into the oxidation gas manifold 560 which the pore 540 forms within the same stack structure by the channels 516-519 with which the feeding-and-discarding box 512 is provided (refer to drawing 29). That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 560 works as an oxidizing gas supply manifold. In each stack structure, the oxidizing gas which passes the oxidation gas manifold 560 is distributed to the oxidizing gas passage in a single cell which the crevice 546 forms, and gathers after that to the oxidation gas manifold 563 which the pore 543 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 563 works as an oxidizing gas exhaust manifold.

[0146]The oxidizing gas which gathered to the oxidation gas manifold 563 which the pore 543 forms results in the return plates 590A thru/or 590D allocated by the end by the side of the application-of-pressure maintaining structure 514 in each stack structure. Here the crevices 591 thru/or 594 (refer to drawing 19 thru/or drawing 22) with which the return plates 590A thru/or 590D are provided, respectively, It laps with the pore 543 and the pore 542 with which the separator 530 is provided within each stack structure, and the oxidation gas manifold 563 which the pore 543 forms, and the oxidation gas manifold 562 which the pore 542 forms are made to open for free passage, as mentioned already. Therefore, the oxidizing gas which has passed the oxidation gas manifold 563 in each of the return plates 590A thru/or 590D, It is introduced into the oxidation gas manifold 562 which the pore 542 forms within the same stack structure by the crevices 591 thru/or 594 (refer to drawing 30). The oxidizing gas which the oxidation gas manifold 562 worked as an oxidizing gas supply manifold, and was introduced into the oxidation gas manifold 562 in the stack structures 515A thru/or 515D, After being distributed to the oxidizing gas passage in a single cell which the crevice 548 forms and passing through the oxidizing gas passage in these single cells, it gathers to the oxidation gas manifold 565 which the pore 545 forms. That is, in the stack structures 515A thru/or 515D, the oxidation gas manifold 565 works as an oxidizing gas exhaust manifold. The oxidizing gas which gathered to the oxidation gas manifold 565 reaches the feeding-and-discarding box 512 again. As mentioned already, the oxidizing gas which had connected the feeding-and-discarding box 512 with the oxidizing gas exhaust provided outside, and passed the oxidation gas manifold 565 is discharged outside via the feeding-and-discarding box 512.

[0147]Although explanation was omitted in the example about the above-mentioned fuel cell 500, the channel which circulates the cooling water for maintaining internal temperature below at a predetermined temperature is also formed in each stack structure which constitutes the fuel cell 500. After such cooling water is also supplied from the outside via the feeding-and-discarding box 512, is distributed to each of four stack structures by the feeding-and-discarding box 512 and passes the inside of each stack structure, it is discharged outside via the feeding-and-discarding box 512.

[0148]In the separator 530 with which the fuel cell 500 of this example is provided, the passage cross section was thinly formed like the separator 430 with which the fuel cell of the 4th example is provided as the crevice which forms the gas passageway in a single cell of the downstream more. That is, in the channel side of fuel gas, a passage sectional area becomes small at the order of the crevice 556,557,558, and a passage sectional area becomes small in the channel side of oxidizing gas at the order of the crevice 547,546,548. Also in the downstream whose total amount of the gas supplied decreases, the gas mass flow per unit passage sectional area is secured by this, and the rate of flow early enough can be secured by it.

[0149]In order according to the fuel cell 500 of the 5th example constituted as mentioned above to divide the gas passageway within each stack structure into plurality and to supply gas one by one to the

divided gas passageway, The gas mass flow which passes per unit sectional area of a channel increases, and the same effect as the example which that the capacity factor of gas improves etc. mentioned already is acquired. Since especially the fuel cell of this example has many single cells which are provided with two or more stack structures and with which the whole fuel cell is provided, it can acquire notably the effect of speeding up the rate of flow of gas and raising the rate of gas utilization. Usually, when there are many single cells with which a fuel cell is provided. In order to raise the rate of flow and to raise the capacity factor of gas, even if it increases the gas supply volume from a gas supply device to a fuel cell, Although the amount of energy which becomes slight [the increment of the gas mass flow in each gas passageway in a single cell], and is consumed for the amount of consumption of fuel or gas pressurization increases, it is difficult to acquire sufficient effect of raising the rate of gas utilization. That is, even if it increases the gas volume which supplies the stack structure which consists of 100 single cells in the fuel cell which it has four, theoretically, the increment of the gas volume in each gas passageway in a single cell drops only to 1/400 of the gas volume to which it was made to increase in a gas supply device. On the other hand, since the fuel cell of this example divides the channel within each stack structure into plurality and supplies gas one by one to the divided gas passageway by forming two or more crevices on a separator, Without increasing the amount of distributed gas from a gas supply device, in spite of having many single cells, the gas volume which passes the gas passageway in a single cell can be made to be able to increase, and the rate of gas utilization can be raised greatly.
[0150]In addition to the above-mentioned effect, the fuel cell of this example does the following effects so. The fuel gas supplied from the outside is first distributed only to the stack structures 515A and 515B, Since the stack structures 515C and 515D are supplied after passing the divided fuel gas flow route which was formed in the stack structure 515A and 515B, Since the flow of the fuel gas supplied to per stack structure compared with the composition which distributes fuel gas to four stack structures simultaneously increases and the gas flow rate in a channel speeds up, the capacity factor of fuel gas can be raised.
[0151]Namely, when distributing fuel gas to four stack structures simultaneously, every [of the fuel gas supplied from a fuel gas feed unit / 4 / 1/] will be supplied to each stack structure, but. In the fuel cell 500 of this example, every [of the fuel gas supplied from a fuel gas feed unit / 2 / 1/] is supplied to each stack structure. Thus, since the fuel gas flow in a channel increases and the capacity factor of gas improves, the total amount of the fuel gas supplied to a fuel cell is also reducible. Usually, in order to fully advance electrochemical reaction with the whole fuel cell, to a fuel cell, supply an excessive amount of gas exceeding gas volume required for a theoretical target, but. When the capacity factor of the gas in a fuel cell improves, even if it reduces the gas volume to supply, it becomes possible to fully advance electrochemical reaction. Such an effect becomes advantageous especially, when using a fuel cell as a power supply for a drive of an electromobile etc. That is, by the ability to reduce the fuel gas amount supplied to a fuel cell, the amount of consumption of the fuel carried in the electromobile can be cut down, and the distance it can run by refueling once can be developed.
[0152]When supplying gas to two or more stack structures, gas is previously supplied to a part of stack structures, In supplying the gas which passed the stack structure of these upstream to the stack structure of the remaining downstream, Since the concentration of an electrode active material becomes high in the direction of the gas supplied to the stack structure of the upstream, or the total amount of the gas supplied increases, and the direction of the stack structure of the upstream obtains sufficient voltage compared with the downstream, it will be advantageous. However, in the fuel cell 500 of this example. Since the divided channel within each stack structure is mutually connected between stack structures and gas is passed by turns between stack structures, on the other hand, only a part of stack structures are not allotted to a target by the downstream, and an output can be equalized with the whole fuel cell.
[0153]When dividing the fuel gas supplied from a fuel gas feed unit furthermore according to the fuel cell 500 of this example, Since gas is divided into two using the feeding-and-discarding box 512, without changing the direction of gas and the stack structures 515A and 515B are supplied, the gas volume supplied to each stack structure can be equalized more. Namely, the thing for which gas is divided into two with sufficient accuracy without changing the flow direction of gas, Compared with

quadrisecting gas in the different direction, technically, since it is far easy, the gas volume supplied to each stack structure can be equalized more, and an output can be equalized more with the whole fuel cell by this.

[0154]In the fuel cell 500 of the 5th above-mentioned example, as mentioned already, in the feeding-and-discarding box 512, we quadrisected oxidizing gas, and decided to supply separately to each stack structure. In using here the reformed gas which reformed and obtained methanol etc. as fuel gas, the hydrogen concentration in fuel gas becomes about 60% order, but. To use air as oxidizing gas, the oxygen density in oxidizing gas needs to supply more oxidizing gas to a fuel cell compared with fuel gas, in order to supply sufficient oxygen for the cathode side, since it becomes about 20%. Between two stack structures, connect mutually like the channel of the fuel gas in the fuel cell of this example, and the channel divided within stack structure fuel gas, A pressure loss will become large, when passing through the inside of both stack structures by turns, and the length of a gas passageway becomes longer and the increase of passage resistance and gas pass through a channel. Therefore, compared with the case where gas is separately supplied to each stack structure, when supplying oxidizing gas, the amount of energy taken to pressurize oxidizing gas becomes large, and the energy efficiency of the whole fuel cell falls. In the fuel cell 500 of this example, in the channel of the oxidizing gas which needs to supply more gas, in order to avoid that channel length becomes long and reduces energy efficiency, it was presupposed to oxidizing gas that each stack structure is supplied separately.

[0155]It is good also as composition which will connect mutually the channel divided within stack structure like the channel side of fuel gas between two stack structures at the channel side of oxidizing gas and to which oxidizing gas will pass through the inside of both stack structures by turns from the first if the grade of decline in energy efficiency is in tolerance level. In such a case, the effect of making the gas mass flow and gas flow rate in a gas passageway increasing to the channel side of oxidizing gas, and raising the capacity factor of gas can be acquired.

[0156]According to the fuel cell 500 of this example, since two or more stack structures are stored in one case, the whole composition is miniaturizable. Especially, have established the feeding-and-discarding box 512 in the center section, and via this feeding-and-discarding box 512, Since supply of gas is received from the exterior, and gas is discharged to the exterior and gas is exchanged between each stack structure via this feeding-and-discarding box 512, piping structure of gas can be made very compact.

[0157]Like this example, establish two or more crevices in the separator surface, each crevice forms the gas passageway in a single cell independently, and the divided gas passageway corresponding to the gas passageway in each single cell is connected mutually, When passing gas one by one among these, it is not necessary to pass gas one by one from the gas passageway in a single cell which the crevice established in the end of the separator forms. In this example, oxidizing gas was carried out to making it pass from the oxidizing gas passage in a single cell which the crevice 547 established in the center section of the separator 530 forms. Although the upstream is considered that gas begins to leak to a surrounding field a little via a gas diffusion electrode by a gas passageway in the channel where gas pressure is high and gas pressure is high, Thus, if the gas passageway in a single cell which the crevice established in the center section of the separator forms is made into the upstream, the gas which began to leak from the gas passageway in a single cell of this upstream will be allocated in both sides, and will become available in the field corresponding to the gas passageway in a single cell of the reliance lower stream. Here, in each oxidizing gas passage in a single cell, since oxidizing gas goes caudad and always flows from the upper part, the produced water produced in a channel is led to a downward oxidizing gas exhaust manifold, and does not take up a channel with the flow of gas. What is necessary is just to remove the produced water led to the oxidizing gas exhaust manifold by providing a sewer valve etc. in each oxidizing gas exhaust manifold.

[0158]In this example, the channel of fuel gas was carried out to making it pass one by one from the gas passageway in a single cell which the crevice established in the end of the separator forms. That is, the fuel gas flow route in a single cell which the crevice 556 of an upper bed part forms became the upstream most, and it formed as the fuel gas flow route in a single cell which the crevice provided

caudad forms so that it might become the downstream. In the fuel gas flow route in each single cell, since fuel gas flows horizontally, the produced water which is having such composition and was produced in the channel, By the flow of gas, it is gradually led to the fuel gas flow route in a single cell of the downstream, and gathers for a downstream fuel gas exhaust manifold (the stack structures 515A and 515B the fuel gas manifold 585 and the stack structures 515C and 515D fuel gas manifold 582) most eventually. Therefore, produced water can be easily removed by providing a sewer valve etc. in this fuel gas exhaust manifold.

[0159]Although the oxidizing gas passage of predetermined shape was formed in the feeding-and-discarding box 512 and we decided to introduce oxidizing gas into the gas passageway into which the downstream was divided more by this channel in the fuel cell 500 of the 5th example, Instead of forming a channel in the feeding-and-discarding box 512, it is good for the end of each stack structure also as allocating a return plate. Namely, besides the return plates 590A-590D provided in the end by the side of the application-of-pressure maintaining structure 514 in each stack structure, It is good also as realizing the same operation as the channels 516-519 which provided the return plate also in the end by the side of the feeding-and-discarding box 512, respectively, and were provided in the feeding-and-discarding box 512 with these return plates. In the fuel cell 500 of the 5th example, although it presupposed that each stack structure is connected in series in order of the stack structures 515A, 515C, 515D, and 515B, it may carry out the method of different connection. For example, it is good also as connecting such stack structures in parallel mutually.

[0160]As mentioned already, in the fuel cell 500 of the 5th example. Since the channel within each stack structure is divided into plurality and gas is supplied one by one to the divided gas passageway by forming two or more crevices on a separator, in spite of having many single cells, Without increasing the amount of distributed gas from a gas supply device, the gas volume which passes the gas passageway in a single cell was able to be made to have been able to increase, and the rate of gas utilization was able to be raised greatly. It becomes possible using such an effect to constitute a fuel cell with few stack structures using the separator provided with two or more crevices like the 5th example. Here, the gas mass flow in each gas passageway in a single cell will decrease, and the capacity factor of gas will fall, so that the number of the single cells with which one stack structure is provided is increased. In order to increase the number of single cells per stack structure, securing the gas mass flow in the gas passageway in a single cell, Since it was accompanied by the increase in the amount of energy consumed in order to make the gas volume supplied to stack structure increase greatly and to pressurize an increase and gas of fuel consumption, the former was difficult for increasing the number of single cells per stack structure. If gas is supplied one by one to the gas passageway which divided the channel within each stack structure into plurality, and divided it using the separator provided with two or more crevices like the 5th example, the number of single cells per stack structure can be increased without being accompanied by the above-mentioned inconvenience.

[0161]Drawing 31 is a fuel cell provided with two stack structures, and is an explanatory view showing the composition of the fuel cell 500 shown in drawing 17, and the fuel cell 600 provided with same number of single cells. Like the fuel cell 500, the fuel cell 600 is constituted using the separator 530, and since the channel within stack structure is divided into three, even if it makes the number of single cells per stack structure increase, it can fully secure the gas mass flow in the gas passageway in a single cell. Thus, by increasing the number of single cells per stack structure, and reducing the number of stack structures, the dead spaces produced in order to dedicate two or more stack structures in a case are reduced, and it becomes possible to miniaturize the whole fuel cell more.

[0162]Although the above-mentioned example explained the polymer electrolyte fuel cell, the composition of this invention is also applicable to the fuel cell of a different kind. For example, also when it applies to a phosphoric acid type fuel cell, a solid oxide fuel cell, etc., the same effect of raising the rate of gas utilization or raising wastewater nature can be acquired.

[0163]As for this invention, although the example of this invention was described above, it is needless to say that it can carry out with the aspect which becomes various within limits which are not limited to such an example at all and do not deviate from the gist of this invention.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, when making rugged structure formed on the gas separator into picture-drawn-without-lifting-the-brush-from-the-paper structure which was described above, since the channel in a single cell is finely bent on the same field, the pressure loss produced when gas passes through such a channel in a single cell will become large. Therefore, in order to maintain the flow of the gas which passes through the inside of a channel to the specified quantity. It is necessary to enlarge the grade which pressurizes the gas supplied to a fuel cell, the energy consumed in order to pressurize gas by this increases, and the inconvenience that the energy efficiency of the whole system provided with a fuel cell will fall is produced.
[0009]The composition which divides into two or more fields the gas passageway formed on a separator apart from the above-mentioned gazette is also proposed (for example, JP,58-138268,U etc.). In such a fuel cell, the gas passageway divided into two or more fields is formed on the gas separator (bipolar plate). The gas supplied in the single cell from the gas supply hole passes through two or more above-mentioned fields one by one, and reaches gas exhaust. Although the rate of flow of the gas which passes through the inside of a channel also as such composition can be made quick and the rate of gas utilization can be raised, The flow of gas as well as the structure of the above-mentioned picture drawn without lifting the brush from the paper is continuing within a single cell, and further, since gas set holes are connected according to a diaphragm, the problem of the above-mentioned pressure loss cannot fully be solved. Since the flow of gas is continuing within a single cell, the composition shown in JP,7-263003,A and the composition shown in JP,58-138268,U have a possibility that distribution of the gas to each single cell may not be performed uniformly enough.
[0010]As described above, to make small the passage cross section of the channel in a single cell, it is necessary to form more finely the rugged structure formed on a gas separator but, and by this, when manufacturing a gas separator, the accuracy more than before will be required. However, when accuracy becomes insufficient with difficulty, raising the accuracy at the time of forming rugged structure in the surface at the time of manufacture of a gas separator. There is a possibility that inconvenience, such as dispersion in the battery capacity resulting from the fall (increase in inferior goods) of the yield at the time of manufacture and the fall of the accuracy at the time of forming rugged structure, may arise.
[0011]The fuel cell using the gas separator for fuel cells of this invention, and this gas separator for fuel cells, Such a problem was solved, it was made for the purpose of raising the capacity factor of the gas supplied to a fuel cell, without reducing the energy efficiency of the whole system provided with a fuel cell, and the next composition was taken.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is an exploded perspective view showing single cell 20 composition which is a basic unit of the stack structure 15.
[Drawing 2]It is a top view showing the composition of the separator 30.
[Drawing 3]It is a perspective view showing the appearance of the stack structure 15.
[Drawing 4]It is an explanatory view showing the shape of the return plate 70.
[Drawing 5]It is a top view showing the composition of the separator 30A which is a modification of the separator 30.
[Drawing 6]It is an explanatory view which expresses the flow of the oxidizing gas within the stack structure 15 in three dimensions.
[Drawing 7]It is an explanatory view which expresses superficially the flow of the oxidizing gas within the stack structure 15.
[Drawing 8]It is an explanatory view which expresses superficially the flow of the fuel gas within the stack structure 15.
[Drawing 9]It is an explanatory view showing the situation of dispersion in the voltage in each single cell which constitutes a fuel cell.
[Drawing 10]It is an explanatory view which expresses temporally the situation of the output voltage in a fuel cell when changing gradually the amount of oxidizing gas (application-of-pressure air) supplied to a fuel cell.
[Drawing 11]The flow of the gas which passes the inside of each oxidizing gas supply manifold and the oxidizing gas exhaust manifold corresponding to this is an explanatory view which expresses superficially signs that the fuel cell which becomes the same was constituted.
[Drawing 12]It is an explanatory view showing the shape of the return plates 90 and 95.
[Drawing 13]It is an explanatory view showing the shape of the return plate 170.
[Drawing 14]It is an explanatory view which expresses superficially the flow of the oxidizing gas within the stack structure 315.
[Drawing 15]It is a top view showing the composition of the separator 430.
[Drawing 16]It is an explanatory view showing the shape of the return plate 470.
[Drawing 17]It is an explanatory view showing the composition of the fuel cell 500 provided with four stack structures.
[Drawing 18]It is a top view showing the composition of the separator 530.
[Drawing 19]It is a top view showing the composition of the return plate 590A.
[Drawing 20]It is a top view showing the composition of the return plate 590B.
[Drawing 21]It is a top view showing the composition of the return plate 590C.
[Drawing 22]It is a top view showing the composition of the return plate 590D.
[Drawing 23]It is an explanatory view showing signs that fuel gas flows in the fuel cell 500.
[Drawing 24]It is an explanatory view showing signs that fuel gas flows in the fuel cell 500.
[Drawing 25]It is an explanatory view showing signs that fuel gas flows in the fuel cell 500.

[Drawing 26]It is a sectional view showing the shape of the channel of the oxidizing gas formed in the feeding-and-discarding box 512.
[Drawing 27]It is a sectional view showing the shape of the channel of the oxidizing gas formed in the feeding-and-discarding box 512.
[Drawing 28]It is an explanatory view showing signs that oxidizing gas flows in the fuel cell 500.
[Drawing 29]It is an explanatory view showing signs that oxidizing gas flows in the fuel cell 500.
[Drawing 30]It is an explanatory view showing signs that oxidizing gas flows in the fuel cell 500.
[Drawing 31]It is an explanatory view showing the composition of the fuel cell 600 provided with two stack structures.
[Drawing 32]It is an explanatory view showing the composition of the separator 130 known conventionally.
[Description of Notations]
15,115,315 -- Stack structure
20 -- Single cell
30, 30A, 130,430,530 -- Separator
31 -- Electrolyte membrane
32 -- Anode
33 -- Cathode
36, 37 -- Collecting electrode plate
36A, 37A -- Output terminal
38, 39 -- Electric insulating plate
40-45 -- Pore
50-53 -- Pore
55-59 -- Rib part
55A-57A -- Uneven part
60-62 -- Oxidizing gas supply manifold
63-65 -- Oxidizing gas exhaust manifold
66, 67 -- Fuel gas supply manifold
68, 69 -- Fuel gas exhaust manifold
70,170,470 -- Return plate
71, 72, 74 -- Crevice
75-78 -- Pore
80, 85 -- End plate
81-84 -- Pore
90, 95 -- Return plate
96 -- Blocking section
140,143 -- Vent
150,152 -- Fuel hole
155 -- Rib part
171 -- Crevice
176 -- Pore
271 -- Crevice
272 -- Crevice
360-365 -- Manifold
440-443,450-453 -- Pore
455,456 -- Crevice
457,458 -- Pore
471,474 -- Crevice
475-478 -- Pore
491,492 -- Pore
500,600 -- Fuel cell

501 -- Pressurizing shafts
502 -- Pressure plate
510 -- Case
512 -- Feeding-and-discarding box
514 -- Application-of-pressure maintaining structure
515A-515D -- Stack structure
516-519 -- Channel
536A-536D and 537A-537D -- Collecting electrode plate
540-545 -- Pore
546-548,556-558 -- Crevice
550-555 -- Pore
556-558 -- Crevice
560-565 -- Oxidation gas manifold
571,572,574,579 -- Crevice
580-585 -- Fuel gas manifold
590A-590D -- Return plate
591-594 -- Crevice

[Translation done.]